Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XXXIX. No. 7. NEW YORK, SATURDAY, AUGUST 17, 1901. ISSUED WEEKLY.

ELECTRICAL REVIEW

PARK ROW BUILDING
13-21 PARK ROW - - NEW YORK
P. O. BOX 339

BY THE
ELECTRICAL REVIEW PUBLISHING COMPANY

CHARLES W. PRICE
PRESIDENT AND TREASURER

STEPHEN H. GODDARD
SECRETARY

CHARLES T. CHILD
TECHNICAL EDITOR

RUSSELL HOWLAND
GENERAL REPRESENTATIVE

WESTERN OFFICE
1612-1613 MARQUETTE BLDG., CHICAGO

LONDON OFFICE
42 OLD BROAD STREET, LONDON, E. C.

REGISTERED CABLE ADDRESS
"ELECTVIEW" - - NEW YORK
TELEPHONE CALL, 21 "CORTLANDT"
(PRIVATE BRANCH EXCHANGE CONNECTING ALL DEPARTMENTS)

SUBSCRIPTIONS TO THE
ELECTRICAL REVIEW

One Year, United States and Canada - - - $3.00
One Year, Foreign Countries - - - - - - 5.00
Single Copies, each - - - - - - - - - .10
Copies can be supplied for only one year back at 25 cents each

TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to insure publication in that week's issue.

An excellent opportunity should be found for the Nernst lamp in street lighting, especially in those places where alternating-current distribution at low frequencies is attempted. It is likely that Nernst lamps will burn excellently well on frequencies of twenty-five cycles, while hitherto neither incandescent nor arc lamps have shown good results at frequencies much below fifty cycles. The popularity of the polyphase distribution and converter substation systems seems to be on the increase and some form of street light that would burn well on twenty-five cycles is a desideratum. Such a light would greatly decrease the expense, which is of great importance in these days of sharp competition among electric lighting companies.

MUNICIPAL OWNERSHIP.

As the time for the fall elections draws near the agitation for municipal ownership of electric lighting plants becomes recrudescent, and here and there its unlaid ghost is visible, causing much perturbation of spirit. It is pleasant to reflect that it is nowhere nearly so rampant a spectre as it was a few years ago. People are beginning to learn by experience—that costly but excellent teacher—that municipal ownership is a snare and a delusion of the first water. A recent example of the benefits following its application may be found in the magnificent bridge between the boroughs of Manhattan and Brooklyn, which has been abused and maltreated and neglected until such evident signs of weakness developed as to necessitate a thorough examination. At present this examination has not been concluded and the results are not available, but the fact that it was ever necessary, and that it was left for police officers and citizens to discover what came very close to being a disastrous break, speaks volumes. This is the sort of thing that municipal ownership has always resulted in, and probably will always result in, in this country at any rate.

The argument of those who advocate the suppression of private property in public service utilities is that the profit made upon the property belongs to the public at large. This particular view of the case might be true if the utility were of such absolutely widespread and universal use as air or water, for example; but with electric light, as with gas, only a certain percentage of the municipal population uses it. If an earning is shown, these users pay it; if a deficit is shown, the remainder of the public pay the deficit for the benefit of the users. Essentially, therefore, municipal ownership of such services is inequitable, even if administered in the very best possible manner.

But time and again it has been shown in this country that municipal institutions are not managed with anything like the business ability that is shown in the conduct of private affairs. What is every man's business is no man's business, and, to some extent, what is every man's property is regarded as no man's property, and particularly liable to the disasters of careless handling, if not to peculations. Whatever the reason may be, and this is beyond our province to discuss, no person of intelligence will deny that in this matter the mismanagement of boards and municipal bodies is absolutely notorious. No kind of property requires more careful handling or more intelligent conduct to produce good results than an electricity supply station. All too often the municipal plant discussion is started by some politician for the benefit that may be derived from appointing his followers to "soft snaps" and easy berths in connection with it. It seems safe to predict that a few years more will see the end of this agitation in the United States.

THE TELEPHONE GIRL AND THE PUBLIC.

Our esteemed neighbor, the New York *Times*, takes issue with some remarks in these columns concerning the part which the public at large should play in increasing the speed of telephone service. It was contended that exchange service is exceedingly good and that a large part of the delay incident to obtaining connection with a called subscriber is due to the dilatory manner in which people answer the telephone. To this the *Times* says:

"This is a view of the existing situation that will not commend itself to the telephone-using portion of the public. In the first place, there is a very firm and general impression that telephone service costs not exactly more than it is worth, but more than it ought to cost, considering the actual amounts invested and the expense of maintenance and operation. Then we all know that there are many delays and annoyances, due not to any dilatoriness of the person at the other end of the line, but to what at least seem to be the needless pranks of the central office staff."

It is a little surprising to see such ex-

pressions as "needless pranks of the central office staff" in our usually well-informed contemporary. As a matter of fact—and we speak from our own knowledge of the subject—practically no business office of any kind is conducted under a more rigid system or with more scrupulous care to suppress "needless pranks" than a telephone central exchange. For example, in all modern exchanges the operators speak only in low tones of voice; they are under the constant supervision of monitors who may put themselves in the circuit between the operator and subscriber at any instant to supervise the former; they are relieved immediately upon showing signs of fatigue or illness, and their conduct is closely watched at all times. These precautions are the outgrowth of a business necessity which is perfectly self-evident. The management of a telephone exchange regards as its first duty the maintenance of the very best possible service and the avoidance of any complaint on the part of the users of the telephone. To this end a practically military state of supervision and obedience has been worked out and practiced for several years. To-day a telephone exchange is organized to work at the highest speed and under the most efficient conditions. The attention of managements has not been confined to betterments of apparatus, but this matter of service has been most carefully and closely studied by people whose living depends on its efficiency.

A visit to one of the exchanges of the New York Telephone Company, for example, would undoubtedly change the point of view of our esteemed contemporary.

It will be very interesting to watch the development of the independent telephone field for the next two years. Before that time it is expected that the Philadelphia exchange will be open, this being the first independent system to start operations in a city of the first class in the eastern part of this country. It looks also as if by the time the Philadelphia exchange is open there will be independent trunk lines connecting Philadelphia with points as far west as the Dakotas and Iowa and virtually covering the intervening country with a network of lines, except in the immediate vicinity of New York. It is probable that this will result in a very considerable cheapening of long-distance telephone tolls, meaning a very greatly increased use of the telephone by the public. It is all a movement toward the inevitable end of the telephone industry in America—the time when the telephone will be as universal as the water faucet, and when any one can talk from his home or place of business to practically any one else.

THE FUTURE OF THE LOCOMOTIVE.

There is a tendency on the part of some people to jump to conclusions and to indulge in the belief that a few years will see the locomotive relegated to museums as a curious object reminiscent of a forgotten age. It is true that the trolley line and the heavy motor car of the interurban railway are making rapid inroads into the lighter traffic of steam railways for short-distance hauling, and it is not improbable that the time will soon come when locomotives hauling suburban trains will be as rare as white blackbirds. But the future of the express and long-distance locomotive is by no means so dark. Roughly speaking, the cost and the difficulty of operating electric railway lines increase somewhere in the neighborhood of the square of the length, other things being equal. It is likely that, unless some revolutionary inventions are made, the locomotive will continue for a very long time to show economy for long-distance work superior to that which may be attained by the use of electricity. The steam locomotive engine is a highly perfected machine and wonderfully efficient and satisfactory for the duties for which it was designed. Instead of disappearing, it seems likely that it will increase in size and power rather than suffer extinction. The place for electric traction is the short and heavily traveled line and in this it is unquestionably destined to become supreme. On the contrary, the steam locomotive, it seems now, must necessarily hold its own as the best appliance for long-distance transportation at high speeds and with heavy loads.

Nowhere in the world is there such a magnificent opportunity for the erection of a high-speed electric railway system as between the cities of New York and Philadelphia. The population gathered at the two ends and along the line is well over seven million. The two cities are manufacturing points of the greatest importance, and one of them is the commercial and social metropolis of the country. The distance is only about ninety miles, and while the cost of erecting such a railway will be very great, there can be no reasonable doubt that from the very beginning it would pay excellent dividends upon any reasonable investment. This seems to be an era of tunnel building and extension of transportation facilities in the neighborhood of New York. The project for tunneling the Hudson River has by no means been abandoned, and from the engineering point of view it presents no exceptional difficulties. There seems no reason to believe that an electric line can not be constructed from centre to centre of the two cities that would carry passengers, on trains making two or three stops, from terminus to terminus in one hour and a half, and very likely might carry passengers through on express trains in one hour. High speed is demanded by the traveling public to-day, especially by those who travel for business, and it is believed that a passenger business of enormous proportions could be done over such a high-speed line connecting these important centres.

THE INSTITUTE'S SUMMER MEETING.

As we go to press the summer meeting of the American Institute of Electrical Engineers is just about to be held in New York city and Buffalo. The programme is very complete and the itinerary—New York, Schenectady, the Pan-American Exposition, Niagara Falls — embraces much of electrical interest, though nothing that will be of much novelty to the Institute's members. It is to be expected, however, that the foreign guests will see much that is new to them, and under the most favorable auspices. Everybody will have a good time, but some straggling away from the meetings to enjoy the exposition may be expected. Even if this is the case, however, the main advantage of the meeting will doubtless be gained—the closer association of members and their better mutual understanding and more general acquaintance with each other.

Science Brevities

Radiation of Incandescent Mantles—Dr. Guillaume, of the Bureau des poids et mesures, discusses the laws of radiation in reference to their application to incandescent mantles, in the *Revue générale des Sciences*. Dr. Guillaume considers that the high intensity of the Auer light is due partly to the fact that the coefficient of radiation of the mantle is exceptionally high toward the blue end of the flame, partly to the temperature of the flame itself being, as the author shows, higher than has been commonly supposed, and partly to the density of the radiating substance being largely in excess of that of the carbon in an ordinary combustion flame. The high temperature of the mantle is probably attributable to the fact that its coefficient of radiation decreases rapidly toward the red end and infra-red of the spectrum, so that the total radiation is relatively small in comparison with the radiation of rays of short wave-length. Dr. Guillaume quotes the work of Messrs. Le Chatelier and Boudouard, and suggests that the coefficient of radiation of the mantles for infra-red rays presents an interesting field of study. It seems probable that as the wave-length increases, the coefficient may decrease to a minimum and may increase again in a region considerably distant from the visible spectrum. The substance used by von Welsbach thus exhibit gaps in an easily explored region of their emission-spectrum, and we may expect to obtain, with little difficulty, results differing considerably from those furnished by the study of substances whose radiation is more nearly uniform.

Magnetic Effect of Electrical Convection—The magnetic effect produced by the motion of an electrified body, first proved by Rowland in 1876, and, though questioned by Cremieu, since then repeatedly confirmed, has been also established by Mr. Harold Pender, at the Johns Hopkins physical laboratory. An account of his experiments is given in a recent issue of the Johns Hopkins University *Circular*. The method of Cremieu, which, however, gave him negative results, was employed. To produce the convection, two micanite disks (diam. 30 cm.) gilded on both sides and charged from a Voss machine and battery of six gallon Leyden jars, were driven at a speed of 75 to 100 revolutions per second. An interrupter made it possible to reverse the charge 12 to 25 times per second. Earth-connected condensing plates were fixed opposite each face of each disk, and one centimetre distant. Between the two inside condensing plates was suspended a coil of 1,295 turns of No. 21 copper wire, connected through a commutating device with an extremely delicate astatic galvanometer. The coil, circuit and galvanometer were enclosed in earth-connected metallic shields. The arrangement of the commutator was such that the alternating currents induced in the coil by the reversal of charge in the rotating disks give a steady deflection of the galvanometer. The apparatus was used in two ways: (*a*) the two disks were rotated in the same direction and at any instant charged alike; and (*b*) the disks were rotated in opposite directions and charged oppositely at any instant; of these, the second method gave steadier deflections and was used more frequently. The direction of deflection, repeatedly tested, was found, as expected, to be always in accordance with Ampere's rule, *i. e.*, the motion of a positive charge always produced the same effect as that of a conduction current flowing in the direction of motion of the charge. The quantitative results are discussed, as follows: "The strength of a convection current is defined as the quantity of electricity carried convectively past any point in unit time. On the assumption that a convection current is magnetically equivalent to a conduction current of the same strength, the current induced in the suspended coil on reversing the sign of electrification of the disks can be readily calculated from the dimensions of the apparatus and the difference of potential between the disks and plates. This calculated value of the current can then be compared with the observed value as deduced from the deflection of the galvanometer. The formula for the calculated value of the current involves the ratio of the two systems of electric units, so that instead of comparing directly the observed and calculated values of the current the two can be equated and the value of the ratio v thus determined. The value of this ratio thus found is a test for the accuracy of the assumption that a convection current is equivalent magnetically to a conduction current. From 17 sets of observations, each set consisting of 18 separate determinations of the deflection and the other quantities involved, the mean value of v thus found was 3.05×10^{10}, the determinations which differed from this the most being 2.75×10^{10} and 3.24×10^{10}, respectively. The value of this constant is known to be 3.00×10^{10}." Similar results were obtained when disks and condensing plates were divided, each into six sectors by radial scratches, thus showing that the effect observed was not due to conduction currents in their surfaces. To prove, further, that the deflection observed was actually due to the magnetic action of the rotating charged disks, a further experiment was tried. The disks were rotated in the same direction and at any instant charged oppositely; and, again, rotated in opposite directions and at any instant charged alike. Their magnetic effects on the coil should then annul one another provided the two disks rotated with the same speed, and this was the result obtained. For example, when the two disks were rotating in same direction with speeds of — 86.9 and — 88.8 revolutions per second, respectively, and charged alike, the observed deflection was — 66.2; when they were rotating oppositely under the same conditions, with speeds + 88.0 and — 89.6, the observed deflection was — 1.0. It is concluded, therefore, that the results obtained "show beyond any doubt *that electrical convection does produce magnetic action;* or, more exactly, that when the sign of electrification of a moving charged body is changed, an electric conduction current is induced in a neighboring circuit, of a strength equal to that which would be induced in this circuit by reversing the direction of a conduction current in a circuit coinciding with the path of the convection current."

Electrical Dispersion in Closed Air Spaces—Herren J. Elster and H. Geitel give an account of their further experiments on electrical dispersion in closed air spaces in the *Physikalische Zeitschrift*. They and Mr. C. T. R. Wilson, of Cambridge, had previously concluded independently that the air, notwithstanding the exclusion of all known influences that increase its electric conductibility, is by no means a perfect insulator, owing to the existence of ions, and that the rate of dissipation increased beyond its original amount in the course of a few days. A possible explanation of this behavior seems to be that dust-laden air is a worse conductor than air which is dust-free; it might be assumed that the increase of conductibility was due to a gradual self-purification of the air by the deposition of the dust particles. To a certain extent this assumption is correct, but as it appeared doubtful that the dissipation was due solely to the air becoming dust-free, artificial means of purifying the air were tried. A minute description of the apparatus employed is contained in the article in question. The principal result arrived at is that the gradual increase of electric conductibility observed in closed air spaces up to a certain limiting value can only be very partially due to the deposition of dust, or to variations of humidity. This is shown in a striking manner in the abnormally high conductibility of the air in cavities and in cellars which have been closed for some time.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XXXIX.

BY W. ELWELL GOLDSBOROUGH.

Now, in the final case, in determining the conditions which obtain when E^{II} is acting alone, we start out by assuming an electro-motive force OA_2^{II}, equal to OA_1^{I} of Fig. 105, impressed upon a system of branch circuits consisting of OA_1 and OA_3 connected in parallel. This vector we will lay off as OA_2^{II} of Fig. 106, and upon it construct the electro-motive-force triangles of the parallel circuits. Since r_1 and x_1 are known, and

$$\tan \phi_1 = \frac{x_1}{r_1}$$

we can lay off OB_1^{II} in the phase position of the current which will flow in the circuit OA_1 and determine the value of this current by substituting the constants of the circuit in Equation 54.

$$I_1^{II} = \frac{E_2^{II}}{\sqrt{r_1^2 + x_1^2}} \qquad (54)$$

By this means the absolute length of OB_1^{II} is determined, and, by extending OB_1^{II} until it intersects the semi-circle described in OA_1^{II} as a diameter, the sides of the electro-motive-force triangle of the circuit OA_1 are defined. In the same way, since r_3 and x_3 are known and

$$\tan \phi_3 = \frac{x_3}{r_3}$$

we can lay off the vector OB_3^{II} in the phase position of the current which will flow in the circuit OA_3. By (54) this length can be determined, and by an extension of OB_3^{II} until it intersects the semi-circle, the position of the heel of the electro-motive-force triangle of the circuit OA_3 is determined. Now, the current which is the resultant of OB_1^{II} and OB_3^{II}, and which must be made to flow in the circuit OA_2, is represented by the vector OB_2^{II}. To force this current through the circuit OA_2 will require an electro-motive force $A_2^{II}A^{II}$, since this electro-motive force is equal to the vector sum of the resistance electro-motive force and the reactance electro-motive force which are developed in the circuit OA_2 when a current I_2^{II}, equal to OB_2^{II}, is flowing. Now, finally, to maintain an electro-motive force OA_2^{II} at the terminals of the circuit OA_2 of Fig. 104, alternator E^{II} must develop an electro-motive force equal to the resultant of OA_2^{II} and $A_2^{II}A^{II}$, or OA^{II}.

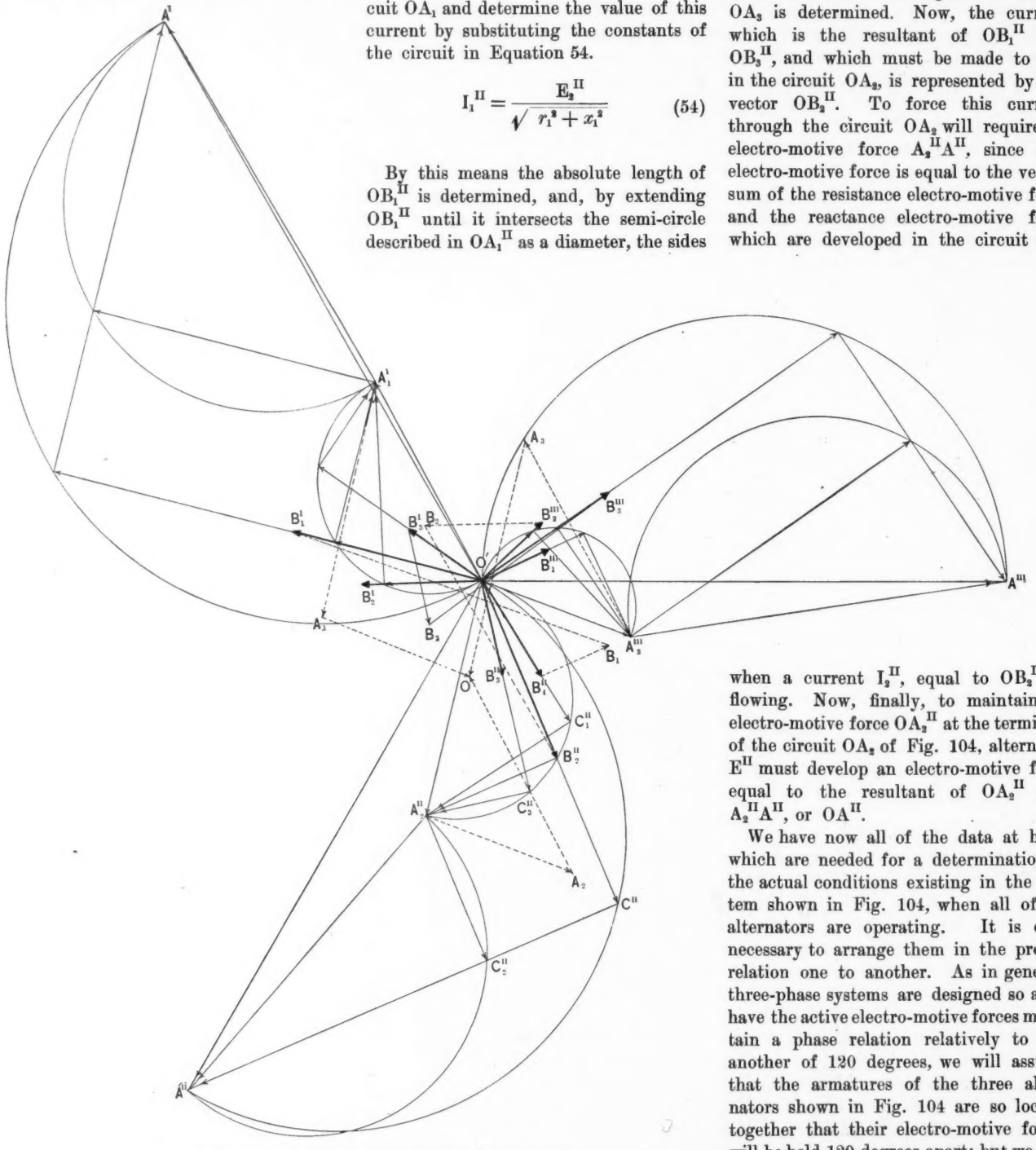


FIG. 108.—ALTERNATING DYNAMO ELECTRIC MECHANISMS.

We have now all of the data at hand which are needed for a determination of the actual conditions existing in the system shown in Fig. 104, when all of the alternators are operating. It is only necessary to arrange them in the proper relation one to another. As in general, three-phase systems are designed so as to have the active electro-motive forces maintain a phase relation relatively to one another of 120 degrees, we will assume that the armatures of the three alternators shown in Fig. 104 are so locked together that their electro-motive forces will be held 120 degrees apart; but we will give the electro-motive forces values differing from one another to such an extent that the system will not be balanced, but present all of the features of unbalanced working. Accordingly, in Fig. 108, the vector $O'A^{I}$ represents the electro-motive force developed by alternator

E^I. Lagging 120 degrees behind $O'A^I$, we have the vector $O'A^{II}$, which represents the electro-motive force developed by alternator E^{II}; and, lastly, lagging 120 degrees behind $O'A^{II}$, and in advance of $O'A^I$ by 120 degrees, we have the vector $O'A^{III}$ equal to the electro-motive force developed by alternator E^{III}.

To complete this diagram we must transfer to Fig. 108 the vector values of Figs. 105, 106 and 107, giving to each vector its proper proportional value relatively to the other diagrams. In transferring the values of Fig. 105 to Fig. 108, the length of each of the vector quantities shown in Fig. 105 must be changed in the ratio of the vector length $O'A^I$ of Fig. 108 to the vector length OA^I of Fig. 105. This proportional change will give the system of vectors enclosed in the semi-circle $O'C^IA^I$. Correspondingly, in transferring the values given in Fig. 106 to Fig. 108, the length of the vectors in Fig. 106 must be increased in the ratio of $O'A^{II}$ of Fig. 108 to OA^{II} of Fig. 106. Carrying out this construction gives us the vector diagram enclosed by the semi-circle $O'C^{II}A^{II}$. Where the values of Fig. 107 are transferred to Fig. 108, the proportional reduction in vector lengths must be made in the ratio of the vector $O'A^{III}$ of Fig. 108 to the vector OA^{III} of Fig. 107: from these reduced values the diagram bounded by the semi-circle $O'C^{III}A^{III}$ and the point A_3^{III} is developed.

To trace out the final resultant vector values from Fig. 108 may appear, at first, to be a somewhat difficult undertaking. However, if it is remembered that when a resultant force in any one of the three circuits is to be determined, the partial vectors due to the corresponding forces of the other two circuits are first to be vectorially added, and then the vector due directly to the force of the circuit in question subtracted from this sum, results will be more easy of accomplishment. For instance, take the determination of the final current which flows in the circuit OA_1 of Fig. 104. Referring to Fig. 108, we find that the electro-motive force E^{II} sets up the current $O'B_1^{II}$ in the circuit OA_1 when it is acting alone, and that the electro-motive force E^{III} sets up the current $O'B_1^{III}$ in this circuit when it is acting alone. The vector sum of $O'B_1^{II}$ and $O'B_1^{III}$ is determined by laying off from B_1^{II} the vector $B_1^{II}B_1$ equal and parallel to $O'B_1^{III}$. Now, the current which the electro-motive force E^I will set up in the circuit OA_1 when it is acting alone upon the whole system is represented in value by the vector $O'B_1^I$. When the final summation is taken this vector must be vectorially subtracted from the sum $O'B_1$ of the vectors $O'B_1^{II}$ and $O'B_1^{III}$. In doing this we simply take the vector distance $B_1^IB_1$, since this is equal to the vectorial difference of $O'B_1^I$ and $O'B_1$.

In like manner, the final current flowing in the circuit OA_2 is determined by taking the sum $O'B_2$ of the vectors $O'B_2^I$ and $O'B_2^{III}$; then connecting the points B_2^{II} and B_2 we have the vector length $B_2^{II}B_2$ equal to the final current flowing in OA_2. The current which will be maintained in the third circuit when all three generators are acting synchronously is the resultant of three partial current vectors, $O'B_3^I$, $O'B_3^{II}$ and OB_3^{III}. Their resultant is obtained by taking the sum of $O'B_3^I$ and $O'B_3^{II}$ and subtracting this sum from the vector $O'B_3^{III}$. When this is carried into effect we have as the resultant the vector distance $B_3^{III}B_3$.

Again, the resultant electro-motive forces acting at the terminals of the several circuits are found in much the same way. When E^I is acting alone it causes an electro-motive force equal to $A_1^IA^I$ to be apparent at the terminals of the circuit OA_1, and when E^{II} is acting alone it causes an electro-motive force equal to $O'A_2^{II}$ to be apparent at the terminals of the same circuit; and, finally, when E^{III} is acting alone, it causes an electro-motive force $O'A_3^{III}$ to be apparent at the terminals OA_1. The resultant electro-motive force which appears at the terminals OA_1 (when all these effects are taken into account) is obtained by taking the vector sum of the vectors $O'A_2^{II}$ and O'^{III}_3, and subtracting from this sum the vector $A_1^IA^I$.

In Fig. 108 this has been accomplished by laying off the vector $A_1^IA_1$ equal and parallel to the vector $O'A_2^{II}$, and from the point A_1 laying off the vector A_1O equal and parallel to $O'A_3^{III}$. The vector distance OA^I will now be equal to the electro-motive force appearing at the terminals OA_1 under the final conditions, since A_1^IO is equal to the vector sum of $O'A_2^{II}$ and $O'A_3^{III}$, and OA^I is equal to the vector differences of A_1^IO and $A_1^IA^I$.

By a similar process the electro-motive force which finally appears at the terminals of the circuit OA_2 is determined by subtracting from the vector $A_2^{II}A^{II}$ the sum of the vectors $O'A_1^I$ and $O'A_3^{III}$. In Fig. 108 this is shown by laying off from the point A_2^{II} the vector $A_2^{II}A_2$ equal and parallel to $O'A_3^{III}$, and from A_2 the vector A_2O equal and parallel to $O'A_1^I$. The distance OA^{II} is therefore the desired resultant.

It is interesting here to note that the resultants OA^I and OA^{II} meet at a common point O. This point is, in fact, the junction point of the three electro-motive forces which are impressed at the terminals of the three component circuits. That the electro-motive force acting on the third circuit meets the other vectors at this point is shown by laying off from A_3^{III} the vector $A_3^{III}A_3$ equal and parallel to $O'A_1^I$, and from A_3 the vector A_3O equal and parallel to $O'A_2^{II}$. By this construction the sum of $O'A_1^I$ and $O'A_2^{II}$ when subtracted from $A_3^{III}A^{III}$ brings the heel of the vector of the electro-motive force apparent at the terminals of the third circuit down to the point O.

Taking a final review of Fig. 108, we see that the heels of the vectors of the electro-motive forces of the three armatures emanate from the point O'; that the heels of the vectors of the three electro-motive forces which are apparent at the terminals of the three circuits join at the point O, and that the heads of the vectors common to each of the three circuits meet at the points A^I, A^{II} and A^{III}. By this arrangement we have a completely closed electro-motive-force diagram. Theoretically, this is to be expected, and the graphical work confirms the theory.

If we wish to determine the value of the electro-motive force between the points A^I and A^{II} of Fig. 104, we have only to measure the vector distance between the points A^I and A^{II} of Fig. 108, and if we wish to determine the difference of potential between the points A^I and A^{III} of Fig. 104, we have only to measure the distance A^IA^{III} of Fig. 108.

Electric Energy from Wind.

From long and careful studies of the atmospheric conditions in northern Germany Herr M. G. Couz, of Hamburg, has taken up the question of the industrial application of the winds which are always abundant in that region. He has discovered a system of electric regulators to obviate the inconvenience of the variation in the velocity of the wind. To put his ideas in practice, Herr Couz appealed to F. Neumann, a manufacturer of windmills at Wittkiel, who put a large windmill at his disposition. The wheel had a regulator to keep its speed constant for a certain number of turns when the minimum velocity of the wind to keep it moving at that speed had been exceeded. This wheel, which in a tempest can furnish 30 horse-power, charges a large storage battery for electric lighting and power at Wittkiel. Some experiments were made last September, and the results surpassed all expectation. These experiments, which were admirably conducted, make it possible to hope that small localities will be able to secure electric light and power from the wind at almost no cost. The expense of establishing such an installation is extremely small in comparison to the immense advantages which it secures.

Selected Chapters in Electrochemistry.

By Harry C. Jones.

CHAPTER IV—ELECTROLYSIS AND THEORIES OF ELECTROLYSIS.

PART II.

THE NEWER THEORIES OF ELECTROLYSIS.

The theory of electrolysis which was held until a few years ago had to take into account the following facts: When a current is passed through a solution of an acid, hydrogen separates at the cathode and oxygen at the anode. This was true, in general, but there were some exceptions as in the case of the electrolysis of a hot, concentrated, solution of hydrochloric acid, where chlorine separated at the anode. If the solution of the acid was dilute the above statement may be taken as general.

If a dilute solution of a base is electrolyzed, hydrogen separates upon the cathode and oxygen upon the anode, in the same way as if an acid was used.

If a dilute solution of a salt is electrolyzed, we will have different results, depending upon the nature of the salt which is used. If we select a salt of a metal which decomposes water, say of the alkalies or alkaline earths, we will have, on electrolysis, oxygen liberated at the anode and hydrogen liberated at the cathode. If, on the other hand, we electrolyze a salt of a metal which does not decompose water, as for example copper, we would have oxygen set free at the anode, and instead of hydrogen being liberated at the cathode, we would have metallic copper deposited upon this pole.

Take first the case of an acid; say hydrochloric acid. The hydrogen ions move with the current over to the cathode, give up their charge to it and escape as hydrogen gas. The chlorine ions move against the current over to the anode, give up their negative charge, but do not escape as chlorine unless the solution is hot and concentrated. The chlorine acts upon the water in the sense of the following equation,

$$H_2O + 2Cl = 2HCl + O,$$

forming hydrochloric acid and setting oxygen free. Two atoms of oxygen combine, forming a molecule, which then escapes as ordinary gaseous oxygen; the hydrochloric acid remaining in the solution again undergoes electrolysis as described above, and the process is continuous. Take the case of a base; say potassium hydroxide. The hydroxyl ions move against the current over to the anode, give up their negative charges to it, and can not escape as oxygen and hydrogen, but two hydroxyl groups react forming a molecule of water and free oxygen, thus:

$$2(OH) = H_2O + O.$$

The potassium cation moves with the current over to the cathode, gives up its charge and becomes a potassium atom. A potassium atom can not, of course, exist in the presence of water without acting chemically upon it, in the sense of the following equation:

$$K + H_2O = KOH + H$$

forming potassium hydroxide and setting hydrogen free. Two atoms of hydrogen then combine, forming a molecule, which escapes as ordinary hydrogen gas. The potassium hydroxide formed undergoes electrolysis as above described, and this process, like that where an acid was employed, is a continuous one.

Take, finally, the electrolysis of a salt. Here we have two cases to deal with, as has already been stated. Take first the simpler case, where the metal in the salt does not decompose water—say copper sulphate. The copper cation moves to the cathode, gives up its charge and separates as metallic copper. The SO_4 anion moves to the anode, gives up its charge, but can not escape. It acts upon a molecule of water, thus:

$$H_2O + SO_4 = H_2SO_4 + O,$$

forming oxygen which escapes, and generating sulphuric acid, which remains in the solution as such if platinum electrodes are employed, or acts upon the electrodes if copper or a similar metal is used, forming the sulphate again which then undergoes electrolysis, as above described. If copper electrodes are used, this process also is continuous.

Let us now take the salt of a metal which decomposes water—say potassium sulphate. The anion SO_4 passed to the anode, and the process at this electrode is exactly as just described, but a very different condition obtains at the cathode. The ion potassium moves to the cathode, gives up its charge and becomes an atom. This reacts with water, as in the case where a base was electrolyzed, forming potassium hydroxide and setting hydrogen free. The potassium hydroxide formed at the cathode reacts chemically with the sulphuric acid formed at the anode, and gives potassium sulphate, which then undergoes electrolysis again as just described. This would continue until all the water present had been decomposed.

The essential feature of this theory is *that water is decomposed by the products of electrolysis,* either at the anode as in the case of an acid; or at the cathode in the case of a base; or at the anode in the case of a salt whose metal does not decompose water; or at both the anode and cathode in the case of a salt whose metal does decompose water. The leading feature to bear in mind is that the *water is not decomposed by the current directly, but that the decomposition of water is a secondary process,* being effected by the primary products of electrolysis, which separate at the poles and then act chemically upon the water present, liberating either oxygen or hydrogen gas.

THIS THEORY NOT SUFFICIENT TO-DAY.

The theory which has just been discussed seems to account so satisfactorily for all the facts that we would naturally ask, why look farther for a new or different theory? The above theory was sufficient for nearly a half-century, but facts have been discovered in the last few years which show that it is no longer tenable.

In the first place it has been shown that although hydrogen and hydroxyl ions can not exist in the presence of each other uncombined to any large extent, yet *water is always slightly dissociated.* The best results seem to indicate that about one molecule of water in every million exists in the form of ions. The discovery of this fact very appreciably complicates the whole problem of electrolysis, since we have to take into account not only the cations and anions which come from the electrolyte, but also those which come from the dissociated water which is always present. Take the case of a very simple salt like sodium chloride. Around the cathode we not only have sodium cations, but also hydrogen cations; and around the anode not only chlorine anions, but hydroxyl anions. The question is, then, when the current is passed, which cations and which anions will give up their charges? It is obvious that that kind of cations and anions which hold their charges *less firmly* will give them up. According to the theory which we have just considered, these are the sodium cations and the chlorine anions. But this theory would also have these ions, which hold their charges less firmly than the hydrogen and hydroxyl ions, and therefore give them

up, take the charges from the hydrogen and hydroxyl ions, respectively, becoming sodium and chlorine ions again. This theory, therefore, contains, in the light of recent experimental discoveries, a self-evident contradiction, and can no longer be regarded as satisfactory.

THE PRESENT THEORY OF ELECTROLYSIS.

It is a very much simpler matter to show that a prevailing conception is not tenable than to propose a theory which will accord with all the facts known, and predict relations as yet undiscovered. It is obvious from the above, that we must abandon the theory of electrolysis which involves the secondary decomposition of water, and look about for a more satisfactory explanation. We shall take up first the theory of electrolysis which is held to-day, and then look to the experimental evidence upon which it is based.

When a current is passed through a solution of hydrochloric acid, we have the hydrogen ions moving toward the cathode, and chlorine ions toward the anode. These are experimental facts, which are independent of any theory. We have, then, around the cathode, hydrogen ions from the dissociated acid, and also hydrogen ions from the dissociated water. Since, however, any hydrogen ion is just like any other hydrogen ion, it does not matter which we regard as giving up its charge to the cathode and escaping as gaseous hydrogen. Around the anode, however, we have two different kinds of anions—chlorine from the dissociated acid and hydroxyl from the dissociated water. Which will give up its charge to the pole? Obviously, the one which holds it less firmly. According to the old theory, it was the chlorine, but according to the new it is the hydroxyl. Two hydroxyl anions lose their negative charges and then form a molecule of water and set oxygen free which escapes from the solution. The chlorine anions suffer no change at the pole; they simply serve to carry the negative current to this electrode, and reform hydrochloric acid with the hydrogen ions of the water.

If we are electrolyzing potassium hydroxide, the facts are that potassium ions move toward the cathode, while hydroxyl ions move toward the anode. Around the cathode we have, then, two kinds of cations —potassium, coming from the hydroxide, and hydrogen, coming from the dissociated portion of the water. Around the anode, however, we have only one kind of anions —hydroxyl coming from the dissociated base, and hydroxyl coming from the dissociated water. The case is the reverse of that which exists when an acid was employed. In the latter case there was a common cation, hydrogen; in the case of a base a common anion, hydroxyl.

When a current is passed through a solution of a base the hydroxyl anions give up their charges to the anode, and form water and oxygen. At the cathode the old theory said it was the potassium ions which gave up their charges, while the new says it is the hydrogen ions from the dissociated water. The potassium cations serve to carry the positive current to the cathode, and form again at this electrode potassium hydroxide with the hydroxyl ions of the water.

The electrolysis of a salt is a little more complicated, but presents no serious difficulty. Take sodium chloride, whose ions are sodium which move to the cathode, and chlorine which move to the anode. We have two kinds of cations around the cathode, sodium and hydrogen; and two kinds of anions around the anode, chlorine and hydroxyl. At the cathode the hydrogen ions give up their charges and escape as gaseous hydrogen; the potassium cations forming potassium hydroxide with the hydroxyl ions from the water. At the anode the hydroxyl anions give up their charges, forming water, and oxygen which escapes; the chlorine anions forming hydrochloric acid with the hydrogen ions from the dissociated water. The base formed at the cathode can then react with the acid formed at the anode and regenerate the salt.

It will be observed that this theory differs fundamentally from the one which was held for such a long time, in that it represents the decomposition of water as being effected directly by the current. We have here *the primary decomposition of water* in electrolysis, while the older theory represented the decomposition of water as a secondary process, produced by the products of electrolysis acting chemically upon the water.

It should be observed that this theory of electrolysis resembles in a striking manner the very early theories, in that it represents the water as being decomposed directly by the current—the electrolyte simply serving to carry the current through the solution, or, as it was said, to make the water a conductor. The new theory, of course, incorporates much that was not contained in the old, having the advantage of a half-century of investigation on these and similar problems.

It is, as we have said, not such a difficult matter to propose a theory as it is to test its truth. How can the theory which we have just considered be tested experimentally?

TESTING THE PRESENT THEORY OF ELECTROLYSIS.

The theory with which we are now dealing could be readily tested experimentally, if we had some means of determining in any given case which of two ions would give up their charge most readily. Such a means has been furnished by Le Blanc, to whom we owe the whole theory which we have just described.

If we attempt to pass a current through a solution of any electrolyte, the result will be dependent upon the electromotive force of the current. If this is below a certain value the current will flow for an instant and then cease to flow, as can be shown by interposing a galvanometer in the circuit of the current. When the current has reached a certain electromotive force, which varies for different electrolytes employed, it will flow continuously, and electrolysis will take place, as already described. This minimum electromotive force, which will just drive the current continuously through the solution of the electrolyte, is known as the "Polarization minimum," or "Decomposition value" of the substance in question. It means that this electromotive force, or potential, is required to cause the particular ions with which we are dealing to give up their charges. By studying the decomposition values of different electrolytes, including acids, bases, and salts, we obtain exactly the data which we need to test this theory —we learn the relative ease with which the different ions give up their charges. A few of the decomposition values of the more common acids, bases, and salts, in normal solution, are given below:

	Decomposition Value.
Sulphuric acid	1.67 volts.
Nitric "	1.69 "
Phosphoric "	1.70 "
Monochloracetic acid	1.72 "
Dichloracetic "	1.66 "
Malonic "	1.69 "
Sodium hydroxide	1.69 "
Potassium "	1.67 "
Ammonium "	1.74 "
Barium nitrate	2.25 "
Strontium "	2.28 "
Calcium "	2.11 "
Potassium "	2.17 "
Sodium "	2.15 "

These are the facts. Let us now see what bearing they have upon the theory in hand. According to this theory the electrolysis of any one *salt* is the same process as the electrolysis of any other salt, since the ions from the salt simply carry the current, while it is the hydrogen and hydroxyl ions from the dissociated water which give up their charges to, and separate at the poles. The decomposition values of salts are the decomposition

values of hydrogen and hydroxyl ions, at the concentrations which obtain, and should be practically the same for all salts. The above results for the decomposition values of salts show that fact and theory are in satisfactory accord.

Take the case of *acids*. These dissociate into hydrogen cations and into anions whose nature depends upon the acid used. Take nitric acid; the hydrogen cations move to the cathode, give up their charges and escape, as we have seen. The anions move to the anode, but do not give up their charges; the hydroxyl anions from the water give up their charges instead; an equal number of hydrogen ions from the dissociated water remaining in solution and reforming nitric acid with the anions. There must, therefore, be a constant decomposition value for acids, which corresponds to the potential required to discharge hydroxyl ions on the one hand and hydrogen ions on the other, under the conditions of concentrations which obtain. Such is seen, from the decomposition values of acids given above, to be the case. This corresponds to about 1.7 volts for normal solutions of acids.

The facts and theory agree so well with acids, we should naturally turn next to *bases*. These yield hydroxyl ions which give up their charges to the anode, form water, and oxygen which escapes. The cations move to the cathode, but do not give up their charges; the hydrogen ions from the water giving up their charges instead. We have here exactly the same processes taking place as in the electrolysis of acids, and the decomposition values of bases should be the same as that of acids of the same concentration, since they are the decomposition values of hydrogen and hydroxyl ions, the product of whose concentration is a constant. Facts and theory, therefore, agree as well in the case of bases as of acids and salts.

There is, however, still one more point which must be considered in connection with the decomposition values given above, in order that the line of reasoning from these values may be complete.

"Acids* and bases of the same concentration must have the same decomposition values, as we have seen, because the product of the number of hydrogen and hydroxyl ions in such solutions must, from the law of mass action, always remain constant. It is, however, quite different with a salt. At the cathode, hydrogen is liberated and a base is formed, which means an increase in the number of hydroxyl ions around this pole; and, similarly, the formation of an acid around the anode increases the number of hydrogen ions around the anode. Since the product of the number of hydrogen and hydroxyl ions which can remain in a solution is a constant, an increase in the number of hydroxyl ions means a decrease in the number of the hydrogen ions present around the cathode, and, similarly, an increase in the number of hydrogen ions around the anode would diminish the number of hydroxyl ions around this pole. Both of these influences would increase the decomposition value.

Here, again, theory and fact are in perfect accord. A comparison of the decomposition values of acids and bases, with those of salts, will show that the latter are considerably larger than the maximum values for the former.

The evidence for the present theory of electrolysis is, then, so satisfactory that we can not hesitate in accepting it as a highly probable explanation of what takes place when a current is passed through a solution of an acid, base, or salt.

The great difficulty which has been encountered in dealing with a process, apparently no more complicated than the electrolysis of an acid, should be noted. It is a general fact that Nature deals out her truth with a sparing hand, and only as the reward of an enormous amount of labor.

THE ELECTROLYTIC SEPARATION OF THE METALS.

There are one or two other matters which must be considered before this chapter is closed, since they are of the very deepest significance for the practical electrochemist. It is not only possible to deposit many of the metals from their ores by means of the current, but to separate the metals from one another electrolytically. In obtaining the metals from their ores, or in purifying them after they have been obtained in a crude form, the conditions under which the electrolysis is effected are somewhat modified from case to case. The great problem here is to use electrodes which are not attacked by the products of electrolysis, and to so modify the conditions that "the yield" may be made as large as possible. For details in this connection reference only can be made to some comprehensive work.*. Suffice it to say that sodium, potassium, lithium, barium, calcium, strontium, aluminum, copper, silver, gold, platinum, and many other metals are now readily obtained by electrolysis.

The problem of electrolytic separation of the metals is of special interest in connection with the matters which we have just considered. If a current is passed through a solution containing several kinds of ions, all of these will take part in carrying the current; the amount carried by any one kind of ions depending upon the relative number of these which are present, and upon their velocity. When these reach the electrode, those with the lowest decomposition values will separate first. If the difference in potential between the electrolyte and electrode is less than the decomposition value of any ion, this will not give up its charge.

The decomposition values of the different ions are very different, and this makes it possible to effect electrolytic separations of the metals. A current of electromotive force just small enough to cause the ion with the lowest decomposition value to separate, is used at first. The electromotive force of the current is then increased until the decomposition value of the next ion is reached, when it will separate, and so on. After all the ions of any given element have separated, the current will cease to flow until its electromotive force has been raised to the decomposition value of the ion next in the series, so that it is not very difficult in practice to so regulate the conditions that good quantitative separations can be effected.

It has, however, been clearly recognized that current strength or current density is an important factor in electrolytic separations, since it conditions the number of ions which will separate in any given time. If the density is great, the ions are rushed over to the electrode so rapidly that time is not given for all the more easily discharged ions to reach the electrode by diffusion, etc., and some of the ions with higher decomposition values may separate. The result is that under these conditions only partial separations are secured.

From the study of the decomposition values of the ions by Le Blanc, Freudenberg, and others, in Ostwald's laboratory, the whole subject of the electrolytic separations of the metals was opened up.

The electrolytic action of the current has also been applied to organic compounds with some remarkable results. Organic acids, as has been stated, dissociate into a hydrogen cation and an anion which comprise the remainder of the molecule. As is well known, organic anions are always complex, and in many cases are very complicated groups. These groups, when they separate at the anode, are generally incapable of existence as such, and either combine with one another and form new products, or break down in-

*From "Elements of Physical Chemistry," by H. C. Jones, which will appear in the near future.

*Borchers' Elektrometallurgie.

to simpler substances. Thus, the anion of acetic acid, $\overline{CH_3COO}$, holds its charge less firmly than hydroxyl, and when it arrives at the anode it gives up its charge, and then, being incapable of existence as such, breaks down in the sense of the following equation:

$$2\overline{CH_3CO_2} = C_2H_6 + 2CO_2.$$

The anion of propionic acid breaks down as follows:

$$2\overline{C_2H_5CO_2} = C_2H_5COOH + C_2H_4.$$

The electrolysis of organic bases has yielded similar results in the few cases which have been studied. The cation of the organic base is too complex to exist uncharged, and when it gives up its charge reactions take place, giving rise to new products. The electrolysis of organic acids has already become an important means of effecting the synthesis of organic compounds, and an examination of the literature will show that the results already obtained are not only of scientific value, but have found their way into the factories as means of synthesizing organic dyestuffs and the like.

The electrolysis of organic compounds is not limited to the acids and bases, but has been extended to other classes of substances, such as the esters. Thus, when the monoethyl ester of malonic acid, or rather the potassium salt of this ester, is subjected to electrolysis, the following reaction takes place:

$$2CH_2\begin{matrix}COOK\\COOC_2H_5\end{matrix} = \begin{matrix}CH_2COOC_2H_5\\CH_2COOC_2H_5\end{matrix} + 2CO_2 + 2K.$$

From the monoester of a dibasic acid, the diester of a dibasic acid richer in carbon was thus obtained. Walker found that this was a more or less general method for passing from one dibasic acid to another richer in carbon atoms.

The application of electrolysis to organic compounds has been just fairly begun, and from what has already been accomplished, it seems probable that much of interest to the man of science and also to the practical electrician, will be discovered in this field.

We have here, then, both in inorganic chemistry and in organic, important branches of industry developed directly out of investigations undertaken and carried out in the interest of pure science. Indeed, this is almost invariably the order of progress. The investigator works and discovers the truth purely for its own sake, just because he desires to know what it is. The practical man applies the knowledge thus obtained, often, however, adding greatly to it, to the welfare of the human race. The importance not only of accurate scientific knowledge, but of scientific investigation in the factory and in the shop, is being felt to such an extent that it has become an absolute necessity; and we see to-day in the large German, and other factories, investigation being carried on to an enormous extent. There is one chemical factory in Germany where more than 100 trained chemists are employed to carry out investigations alone, and many others with a smaller number; and this suggests another thought. The men selected to carry out investigations in the great factories and shops in the world are not men who have had a narrow, one-sided training, in a few things, but those who have had broad training along purely scientific lines. It is now fully recognized that men who have been trained first in pure science are best equipped for any line of technical work. In a word, the proper place to lay the foundation for the career of the practical man is in the University.

The next chapter will deal with the velocities with which the ions move through solutions, and some of the methods for determining these velocities.

Finsen Light Treatment of Lupus.

A department for the treatment of *lupus vulgaris* has been opened at the Manchester and Salford Hospital in England. At present one arc lamp of about 30,000 nominal candle-power has been installed, but by an arrangement of collectors four patients can be treated at the same time. The collectors are made of Siberian rock crystal filled with distilled water. The portion of the skin being treated is compressed with two pieces of glass set in a metal frame, between which a constant stream of cold water is kept running. The pressure is to remove the blood from the skin, while the flow of water helps to further keep the skin cool. About a quarter of a square inch is treated for about 50 minutes; antiseptic ointment is then put on, and in a few days the skin is completely healed. Twenty patients can be treated each day, and although the treatment has been in operation for only a month, 34 patients are waiting for a vacancy.

The Elberfeld-Barmen suspension railway is being operated successfully. There are 26 cars in use at the present time and new cars are being made. The cars are running on intervals of about two and one-half minutes and are occasionally overcrowded. The doors can not be opened before the conductor has released the electromagnetic bolt.

High-Speed Electric Traction Experiments in Germany.

F. H. Mason, United States Consul-General at Berlin, reports as follows upon some traction experiments to be made in Germany: There was organized at Berlin on October 10, 1899, a so-called "Studien Gesellschaft," or "company for experiments," in high-speed traction. This company, which has for its president, Dr. Schulz, chief of the Imperial Railway Administration, includes as members the General Electric Company, of Berlin, Messrs. Siemens & Halske, the great machine builders Borsig, Krupp, Halzmann and Van der Zuypen & Charlier, besides several banks, which undertook to supply the capital of 750,000 marks ($178,500) for the necessary expenses of construction. The Studien Gesellschaft thus represents the foremost scientific and mechanical ability of Germany. After more than a year of study and experiment with motors, conductors, and especially the task of taking up an electrical current by a motor car moving at high speed, Director Rathenau, of the General Electric Company, in January of this year, had a formal interview with the German Emperor, in which he submitted a plan for using as an experimental electric line the military railway leading southward from Berlin to Zossen, a distance of 30 kilometres (18.6 miles). The proposition of Mr. Rathenau was promptly and fully approved, and from that moment the whole scheme has had the active support of the Imperial Government. The line to Zossen is now in process of preparation for the trials, which, it is expected, will begin in August or September. For these experiments two motor cars will be, or have been, built—one by the General Electric Company, the other by Messrs. Siemens & Halske. Each will carry about 50 passengers, and efforts will be made to attain a speed of from 125 to 150 miles an hour. Meanwhile Messrs. Siemens & Halske have been making some preliminary tests on a short provisional line, which was built for experimental purposes a year or two ago, at their works at Lichterfelde, near Berlin. The motive of these preliminary trials has been to test the important but hitherto undemonstrated point whether a motor car moving at a speed of 100 miles an hour or more will take the current readily from a three-phase line.

Between Liverpool and Manchester, England, the monorail electric road is now assured. The committee of the House of Commons, to which the matter was referred, has sanctioned the enterprise, and the House of Lords gave its consent some time ago.

THE ELECTROMAGNETIC EFFECTS OF MOVING CHARGED SPHERES.*

BY EDWIN P. ADAMS.

The magnetic effects due to moving charges were first shown experimentally by Professor Rowland † in 1876. Dr. E. Lecher‡ in 1884, thinking that the importance of the experiment rendered its repetition desirable, did so, but with negative results. Insufficient data regarding his experiment make it difficult to point out the cause of his failure to obtain the effect. Since then, Professor Rowland's results have been fully confirmed by Professor W. C. Roentgen § in 1885; by Rowland and Hutchinson ‖ in 1889; and by Professor F. Himstedt ¶ later in the same year.

The next experimental attack upon this problem was by M. V. Cremieu** at Paris in 1900-1. His experiments were originally undertaken to determine whether a changing magnetic field exerts a mechanical force upon an electrically charged body. The negative results obtained led him to undertake a series of experiments on the magnetic effect of moving electric charges. The results of these experiments are apparently all opposed to the results obtained by the above observers. The data which have thus far appeared do not give sufficient details to render it certain that positive results should have been expected. Cremieu himself states that he is convinced that the effect does not exist.

The great importance of the experiment would seem to render further investigation desirable, and the present paper contains a description of an experiment with this end in view.

All previous experiments have been made with rotating disks. With one exception the direct effect of a charged rotating disk upon a magnetic needle has been examined. The exception referred to is the method employed by Cremieu in one of his experiments, where he sought to observe the inductive effect of charging and discharging a rotating disk upon a neighboring coil of wire in circuit with a sensitive galvanometer.

The use of charged spheres was suggested by Professor J. J. Thomson †† in 1881, and he gives a calculation of the magnetic force which would be produced by the motion of a sphere charged to the highest possible potential. In many respects this seems the most natural method of procedure, and was adopted in this experiment. The description of the apparatus employed follows.

A hollow brass shaft, AA (Figs. 1 and 2), is separated into two portions by the hard wood bar B. The shaft turns in fibre bearings, and the pulley and belt at D, Fig. 2, communicate power from the countershaft FF. The spheres which carry the electric charges are spun out of sheet copper into hemispheres, soldered together. There are two sets of spheres, 16 in each set. Brass rods pass through the hollow spheres, and are soldered to them. These brass rods are screwed into collars carried on the axle. The two sets of spheres are thus insulated from each other by the hard wood bar, eight centimetres in length. The electricity is communicated to the two portions of the axle by the copper brushes CC, Fig. 2, and the spheres, being in contact with the axle, thus become charged themselves.

The speed-counter E, Fig. 2, is directly attached to one end of the axle. The gearing is so proportioned that one revolution of the crown-gear and dial I corresponds to 500 revolutions of the axle.

The magnetic system upon which the direct effect of the moving charged spheres is observed, is enclosed in the brass tube H, closed on the bottom by a glass plate coated with tin-foil. This tin-foil is cut into strips parallel to the axle for the purpose of preventing conduction currents flowing in it in a direction in which they could cause a deflection of the needle. The needle-system is carried on a piece of mica, 7.5 centimetres long and 1.25 centimetres wide. Pieces of well-hardened, magnetized watch-spring are cemented at the lower edge and near the upper edge of the mica so as to form an astatic system. The needles are placed perpendicularly to the axle. The mirror is also cemented to the mica, a little above its centre, and is observed through an opening in the brass tube at S, covered with a thin glass plate. The whole needle-system is suspended by a quartz fibre, 32 centimetres in length.

The magnetometer tube H is carried in a brass collar P, which is screwed to the brass plate M. This plate is provided with leveling screws, and rests on the board shelf N, supported at its ends on two brick piers. Underneath the leveling screws are placed pieces of felt, to take up any mechanical vibrations. By means of control-magnets placed on the brass plate M any required degree of sensitiveness can be given to the needle-system. All metallic parts of the magnetometer tube and supports are earthed. A single turn of wire at K serves to determine the needle-constant. The deflections are read by means of the telescope and scale T, placed at a distance of three metres from the mirror.

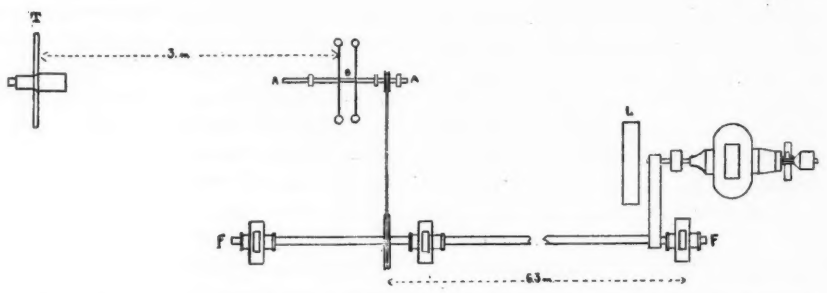


FIG. 1.—DIAGRAM OF APPARATUS FOR STUDYING ELECTROMAGNETIC EFFECT OF MOVING CHARGED SPHERES.

Power for driving the spheres is furnished by a four-horse-power motor, at a distance of seven metres from the magnetometer. A heavy iron casting, L, in front of the motor, gives additional screening of magnetic disturbances due to the motor. The motor is belted to the steel countershaft, FF, which turns in hangers placed along the cement floor. A rigid wooden framework is built up from the floor to carry the revolving spheres. The axle AA is at a distance of one metre from the floor. The brick piers which support the magnetometer are entirely separate from the floor and from the the framework which carries the spheres.

The electricity for charging the spheres is furnished by the battery of 10,000 storage cells used by Professor Trowbridge in investigations in spectrum analysis, etc., and which has been described by him in the *American Journal of Science.* The battery is on the third floor of the laboratory, while the apparatus for this experiment was set up in the basement. The wires leading down from the battery are well separated from each other and from surrounding walls, except for a short distance, where they are carried in thick-

*From the *American Journal of Science.*
†*American Journal of Science* (3), xv, p. 30, 1878.
‡ *Rep. d. Phys.*, **xx**$_8$ p. 151, 1884.
§ *Sitz. d. Berlin Akad.*, p. 198, 1885.
‖ *Phil. Mag.* (5), xxvii, p. 445, 1889.
¶ *Wied. Ann.*, xxxviii, p. 560, 1889.
** *Comptes Rendus*, cxxx, p. 1541; cxxxi, p. 578; cxxxi, p. 797; cxxxii p. 327.
††*Phil. Mag.*, xi, p. 236, 181.

walled glass tubes. A commutator is inserted to reverse the sign of the charges of the spheres.

A good deal of difficulty was met with due to the wind produced by the revolving spheres. These have a velocity of about three miles a minute, and the wind was sufficient to shake the shelf supporting the magnetometer so that it was impossible to take readings owing to the continual vibration of the needle-system. This made it necessary to build a shield around the spheres to keep the wind from blowing directly on any part of the magnetometer support. In order to bring the needles as close as possible to the spheres, the top board of the shield has a hole cut in it into which the lower end of the magnetometer tube is placed. The hole is closed on the bottom by a very thin glass plate, which the spheres just clear when revolving.

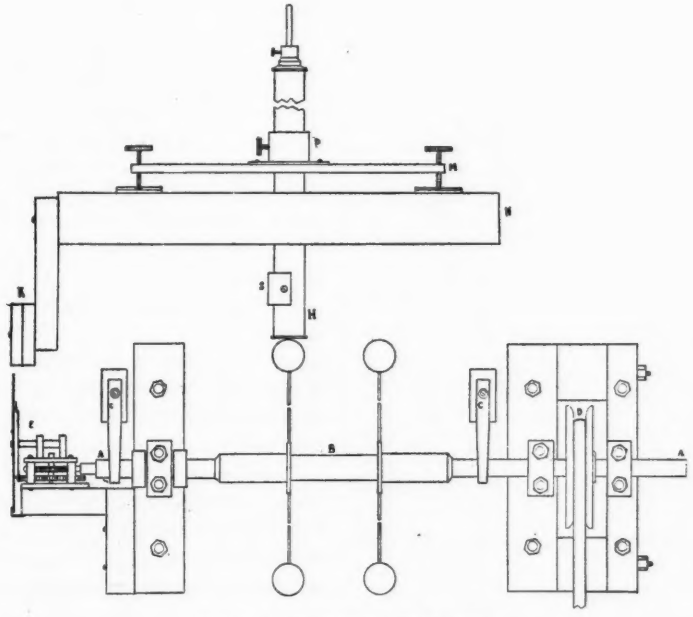


FIG. 2.—DETAILS OF APPARATUS.

Not the slightest movement of the needle could be observed when the motor alone was run, or when the motor and steel-shaft along the floor were run. But the cutting of the earth's magnetism by the brass axle was sufficient to produce a deflection of several centimetres. As long as the speed remained perfectly constant this gave no trouble. But if the speed varied by even a small amount this was very troublesome, and was one of the principal sources of error in the experiment.

The two sets of spheres are charged oppositely, one being connected to the positive pole of the battery and the other to the negative pole. On charging them, while at rest, a very small deflection was observed. This was not due to direct electrostatic effect, but to the rush of current flowing in to charge the spheres. It is only an instantaneous effect, the needle coming back to its original position of equilibrium almost immediately. This deflection was entirely gotten rid of by inserting a large water-resistance in series with the battery. With this resistance in, and the spheres at rest, no effect could be observed on the needle when the spheres were charged, or when the charge was reversed in sign.

When the spheres were set revolving, and the electrification was reversed, a distinct deflection of the needle was produced. It was difficult always to get satisfactory readings of this deflection due to slight changes in the speed and the consequent change of the zero-point. But the qualitative effect was unmistakable. The deflection was in the direction to be expected; that is, a positively charged sphere gives rise to a magnetic force in the same sense as a current flowing in the direction of motion.

At first sight there seems to be a possible alternative explanation of this effect. It may be that the charges are continually swept off from the rapidly moving spheres by their motion through the air, and that thus a continual flow of electricity is produced in the wires which connect the battery to the spheres. But the strength of such a current, if it existed, would be far too small to produce the observed effects owing to the very large resistance of the water in series with the battery. With this consideration, and the absolute regularity with which the effect was observed, there appears to be no reasonable doubt that this is an actual magnetic effect due to moving charges.

All observations were made between the hours of one and five in the morning. It was impossible to get any satisfactory readings in the daytime, owing mainly to the magnetic disturbances produced by the electric cars. Furthermore, the speed of the motor was more constant at that time than during the day, since the load on the mains of the power plant varied less. It was found most satisfactory to have the sensitiveness of the needle such that a deflection of 5 to 15 millimetres was produced on reversing the electrification. Much greater sensitiveness could easily have been obtained, but the zero-point varied so much that the readings were less reliable. The speed used was about 50 revolutions per second. At this speed no trouble was experienced from wind or from vibrations communicated directly to the magnetic system. But when the speed exceeded 60 revolutions per second the needle began to vibrate sufficiently to make observations difficult.

The following is the method used in taking a series of readings. The motor was started, and the time of 2,500 revolutions of the axle determined. The spheres were then charged; two elongations of the needle on one side of the zero-position were read, and one on the other side; the electrification was then reversed, and similar readings taken. Sometimes the readings were not taken until the needle had come nearly to rest, and its new equilibrium position estimated. This was repeated until about 10 reversals had been made. The speed was then again determined. The average of the deflections, and the average of the two values of the speed were taken as representing the series. The needle constant was determined before and after a number of series.

An attempt will be made in the following to compare the results obtained with the results expected from theory. From reasons which will appear later this comparison can be regarded only as approximate, and is given merely to show that the observed results are of the right order of magnitude. Rowland's method of using the experiment to determine V, the ratio of the units, will be used.

The magnetic force produced by a moving charge, q, traveling at velocity v, is:*

$$H = \frac{qv \sin \epsilon}{\rho^2}$$

where ρ is the radius vector drawn from

*J. J. Thomson, *Phil Mag*, xi, p. 236, 1881; Heaviside, *Electrical Papers*, vol. ii, p. 505.

the charge to the point at which H is measured, and ϵ is the angle between ρ and the direction of motion. This expression holds only in case the velocity v is small compared with the velocity of light. This may also be taken as the magnetic force produced by a moving charged sphere, the charge being supposed concentrated at its centre. The force acts in a direction perpendicular to ρ and to the direction of motion.

The magnetic force at either the upper or lower needle, due to one of the spheres at any point in its path, is found as follows:

The two sets of spheres revolve in two parallel circles, distant b from each other. The plane of revolution is taken perpendicular to the plane of the paper, Fig. 3. The needles lie in one of the planes of revolution. The force at P due to the sphere at A is required.

ρ = PA.
b = OB.
d = PB.
c = OC = OA = radius of revolution.
ϵ = angle between ρ and tangent at A.
θ = angle between vertical radius and radius to A.

$$\rho^2 = d^2 + b^2 + c^2 - 2c\sqrt{d^2 + b^2}\cos\phi$$

$$\cos\phi = \cos\theta\frac{d}{\sqrt{d^2 + b^2}}$$

$$\rho^2 = d^2 + b^2 + c^2 - 2dc\cos\theta$$

$$\cos\epsilon = \frac{d\sin\theta}{\rho}$$

$$\sin\epsilon = \sqrt{\frac{(d\cos\theta - c)^2 + b^2}{d^2 + b^2 + c^2 - 2dc\cos\theta}}$$

The force acts in a direction perpendicular to ρ and the tangent at A. The component of this force in the direction of the normal to the plane of revolution is required. Let Ψ be the angle between the direction of the force and the normal to the plane of revolution.

$$\cos\Psi = \frac{d\cos\theta - c}{\sqrt{(d\cos\theta - c)^2 + b^2}}$$

$$v = 2\pi cN$$

where N is the number of revolutions per second.

Hence:

$$X = \frac{2\pi Ncq\,(d\cos\theta - c)}{V[d^2 + b^2 + c^2 - 2dc\cos\theta]^{\frac{3}{2}}}$$

X is the component of the force at P in the direction of the axle due to the sphere at A. V is the ratio of the units. The capacity of the spheres and their potential are measured in electrostatic units.

Fig. 4 is plotted from this expression, and shows how the force varies with the position of the spheres. The upper curve gives the resultant force at the lower needle due to both sets of spheres, and the lower curve, which is nearly a straight line, gives the force at the upper needle. Let the mean value of the force at the lower needle obtained by time-integration of the curve be:

$$\frac{2\pi Nq}{V}\,A$$

and the mean value of the force at the upper needle:

$$\frac{2\pi Nq}{V}\,B$$

Then the effect on the needle will be the same as if constant forces of these magnitudes acted upon it. The same result could be obtained by imagining two coils of wire passing through the centres of the two sets of spheres through which a current was sent in opposite directions

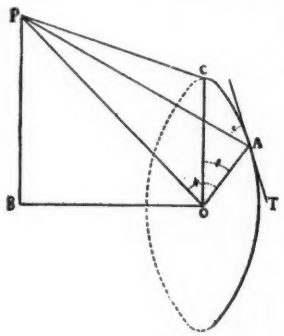


FIG. 3.—DIAGRAM OF MAGNETIC FORCES.

of such a magnitude that the same amount of electricity passed any point per second as in the case of the charged spheres.

Force at lower needle due to calibrating coil:

$$\frac{2\pi\,Ih^2}{(h^2 + x^2)^{\frac{3}{2}}} = 2\pi\,IC$$

h being the radius of the coil, and x its distance from the plane of the needles.

Force at upper needle due to calibrating coil:

$$2\pi\,I\left[\frac{1}{r}\left(\frac{h}{r}\right)^2 P_2(\cos\theta) - \frac{1}{r}\frac{3}{2}\left(\frac{h}{r}\right)^4 P_4(\cos\theta) + \ldots\ldots\right] = 2\pi\,ID$$

r being the distance of the centre of the coil to the upper needle, and θ the angle between the axis of the coil and r.

Let M be the moment of the lower needle, and H the earth's horizontal magnetic force at its centre; M′ and H′ the corresponding values for the upper needle. Let θ be the angular deflection of the needle-system produced by the current in the calibrating coil, and ϕ the angular deflection produced by the moving charged spheres.

Equating the couple acting on the needle-system due to the earth's field to the couple acting on the needle-system due to the current in the calibrating coil, and putting M/M′ = 1, we have:

$$\frac{HM - H'M'}{M} = \frac{2\pi I(C - D)}{\tan\theta}$$

Similarly, equating the couple acting on the needle-system due to the earth's field to the couple acting on the needle-system due to the revolving charged spheres, we have:

$$\frac{HM - H'M'}{M} = \frac{2\pi Nq(A - B)}{V\tan\phi}$$

Hence
$$V = \frac{A - B}{C - D}\frac{Nq}{I}\frac{\tan\theta}{\tan\phi}$$

Let δ be the scale deflection on reversing the current I in the calibrating coil, and Δ the scale deflection on reversing the charges of the spheres. Then:

$$V = \frac{A - B}{C - D}\frac{Nq}{I}\frac{\delta}{\Delta}$$

d and d', the distances of the centres of the lower and upper needles respectively from the axle, were determined by means of a cathetometer, the distance of the mirror from the centre of the axle being directly measured, from which d and d' were obtained.

The current sent through the calibrating coil for determining the needle constant was measured by a Weston milliammeter. The value found was accurate to at least one-half of one per cent, which is sufficient for this purpose.

The charge of the spheres is the most uncertain element in the quantitative determination, and it is this uncertainty especially which makes the method of revolving spheres far less suitable for quantitative work than the method of rotating disks, particularly as employed by Rowland in his second experiment. If a single set of spheres had been used, charged to the same potential, an equal opposite charge would have been induced on neighboring conductors which would have traveled with the charges on the spheres. It would have been difficult to determine just what the resultant effect should be. For this reason two distinct sets of spheres were used, charged oppositely, the spheres always keeping the same relative positions. It was then assumed that the only moving charges were those carried on the moving spheres. The capacity of the spheres was calculated on the assumption that they were the only conductors pres-

ent. The charge on any one sphere was calculated by the method of images, the charges on all the other spheres being regarded as concentrated at their centres. We then have (Maxwell, vol. i, section 159):

$\pm q$ = charge of each sphere.
$\pm P$ = its potential.
a = its radius.

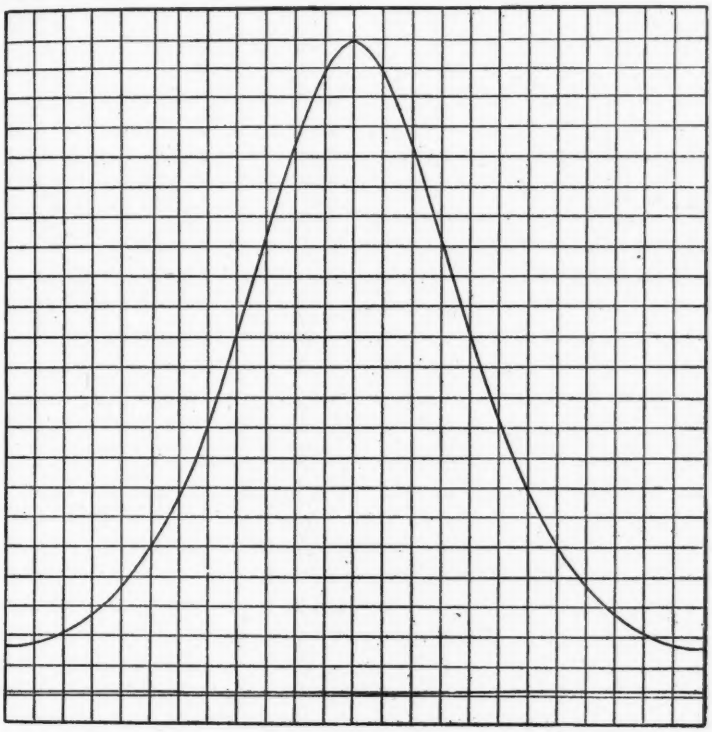


FIG. 4.—CURVE OF VARIATION OF FORCE WITH POSITION OF SPHERES.

f_1, f_2, etc., = the distance of the centres of the spheres from one another.

Then the charge on any sphere is given by:

$$q = Pa - qa\left(\frac{1}{f_1} + \frac{1}{f_3} + \ldots\right) + qa\left(\frac{1}{f_2} + \frac{1}{f_4} + \ldots\right)$$

where the odd subscripts refer to spheres of the same set and even subscripts to spheres of the other set.

Numerous determinations have shown that the potential of the individual cells making up the battery averages is almost exactly two volts when freshly charged. On this basis, assuming perfect insulation, the potential used was 20,000 volts. It was thought best, however, to get a closer estimate of the potential, since the insulation was not perfect. This was measured by means of a guard-ring electrometer. If the radius of the movable disk is R, the inside radius of the guard-ring R', D the distance between the movable disk and the fixed disk, W the weight required to balance the attraction of the two disks, and g the acceleration of gravity,*

$$P = 4D\sqrt{\frac{gW}{R^2 + R'^2}}$$

R = 5.933
R' = 6.033
g = 980.

The following determinations were made:

D	G	P
3.0	2.078	64.0
2.5	2.780	62.0
2.0	4.505	63.0

These values of the potential are in electrostatic units. To convert into volts multiply by 300, and the potential as measured by the electrometer is 18,900.

As a further check the maximum sparking distance between two metallic spheres was measured. With polished brass spheres, 2.6 centimetres in diameter, this distance was found to be 0.58 centimetre. According to the observations of Baille,† this corresponds to a potential:

P = 63

Baille's observations were with spheres of different sizes. In the region of a spark-length of this magnitude, he found that spheres of three centimetres diameter gave nearly the same results as spheres one centimetre in diameter, so that his results for spheres of three centimetres diameter can be used with very small error for spheres 2.6 centimetres in diameter.

From these determinations, the value

P = 63

in electrostatic units is taken as the potential of the sphere. The great advantage in using a storage battery as the source of electricity is that one measurement is sufficient to determine the potential. The battery when used was always freshly charged, and the variations in its potential from one experiment to another were very small.

Substituting the following numerical values:

Radius of spheres = 1.55
c = 20.38
d = 22.91
d' = 29.28
b = 8.16
x = 19.30
h = 2.55

we find

A–B = 1.541
C–D = 0.000232
q = 1.38×63

Below are given the successive equilibrium positions of the needle in six series of reversals, as an illustration of the results that have been obtained:

No. 1.		No. 2.		No. 3.	
	63		165		130
60	66	172	178	109	122
64	76	188	223	122	130
71	79	200	220	112	130
69	76	213		121	140
69				146	156
				164	171
				162	

The needles were then moved a little closer to the spheres, giving:

d = 22.47
d' = 28.84
A–B = 1.834

No. 4.		No. 5.		No. 6.	
92	114		164	108	84
106	135	148	156	113	118
120	135	148	149	108	155
142	149	152	143	125	135
164	192	139	155		
		147			

In all these cases, the first column gives the readings when the spheres directly under the magnetometer are positively charged, and the second column when they are negatively charged. In No. 1, the successive deflections are: 3, 6, 2, 12, 5, 8, 10, 7, 7; giving an average of 6.7. In No. 4 they are: 21, 13, 0, 8, 18, 18, 9, 19, —6, 10, —8, 7, 9; giving an average

*Maxwell, volume i, section 217.
†J. J. Thomson, Recent Researches, p. 77.

of 9. It is evident that with variations such as are present here the measurements can be regarded only as a rough approximation. But the most important fact to be observed is that when the spheres directly under the magnetometer are changed from negative to positive a deflection toward the small figures of the scale takes place, and when changed from positive to negative a reverse deflection takes place. When on account of changes in the zero-point some of the deflections do not apparently follow this rule, they are entered with a negative sign in finding the average deflection. There has invariably resulted a positive deflection on taking the average.

Earlier experiments were made with four spheres in each set. With this number it was possible to get much higher speeds—75 to 85 revolutions per second. Similar qualitative results were observed, but when comparison with theory was attempted it appeared that fair agreement could be obtained if the maximum value of the magnetic force were used instead of the average. This was largely an accidental result, a sufficient number of reversals not having been made.

It would have been desirable to have made a larger number of reversals in each series, but after the apparatus had been running for some time the bearings heated so much that it was impracticable.

The following table gives the values of the ratio of the units obtained from the above readings:

No.	N	A	I	δ	V	
1	42	6.7	.00364	26	2.6	10^{10}
2	55	10.6	.00355	31	2.6	
3	55	9.0	.00355	31	3.1	
4	49	11.3	.00298	29	2.9	
5	41	5.5	.00280	15	2.7	
6	48	7.0	.00280	15	2.6	
Average.....					2.8	10^{10}

These results may be taken as fairly representing all that have been obtained. The agreement between theory and experiment is fully as good as could be expected when all the uncertain elements in the determination are taken into consideration.

These uncertain elements are: (1) The actual charges carried by the spheres and the effect of surrounding bodies, especially the plate coated with tin-foil covering the lower end of the magnetometer tube. This tin-foil is cut into strips about one millimetre in width and its effect must be small. (2) The non-uniformity of the distribution of electricity upon the spheres so that the charges can not be regarded accurately as concentrated at their centres. (3) Errors in reading the deflection of the needle due to outside disturbances.

Experiments have also been made with the direction of motion of the spheres reversed. The results obtained are similar in every respect to those given above, except that they are reversed. Experiments using only a portion of the 10,000 cells of the storage battery gave results which agree fairly well with the preceding. The deflections were too small, however, to expect very close agreement.

The Need for Transportable Electrical Machinery.

To the Editor of the Electrical Review:

I am interested in a placer mine situated on the Amazonian slope of the Andes, somewhat north of Lake Titicaca, not far from the Bolivian border. It is about 150 miles from the railroad, the trail passing over several ranges, the highest point traversed being nearly 17,000 feet above sea level; in many places the trail is very rough and difficult. This describes the difficulty of the route but feebly. The mules of that region are not very large, and the largest weight which they can carry with safety is 200 pounds; even with this weight they sometimes fall from the trail and are lost. I am desirous of introducing machinery to operate with, but the above limitation I find to be very serious and difficult to overcome. The machines in the market, which would be applicable, are generally too heavy and are not separable to an extent that would bring them within the limitations of weight indicated. That is, the heaviest part weighs considerably more than 200 pounds. Even the number of mules available, capable of carrying 200 pounds, is limited. The chief method of transport over the mountains is by llamas. These can carry about 100 pounds each, but can do this most conveniently in packages of 50 pounds each. While they have been known to carry weights of 125 pounds, these animals are very likely to lie down and refuse to go on if the loads which are placed upon them exceed 100 pounds.

At the site of the mine where we are operating there is an ample supply of water, and one naturally turns to consider the possibilities of utilizing this by transforming it into electric energy. In inquiries among manufacturers of electric machinery I find that it is not possible to secure dynamos and motors having an equivalent power of more than about 10 horse-power that is made of separable parts within the limits above indicated. The armature appears to be the part which fixes the limit of size which can be transported. It is desirable that the dynamos sent out may be so that we may have units of not less than the equivalent of 20 horse-power, while the motors might be of 10 horse-power, keeping, in both cases, within the limit of maximum piece not to exceed 200 pounds.

I find that requirements such as mine are not uncommon, and that a very much wider field for the use of electric machinery would be opened, if our manufacturers would design and make a class of dynamos and motors having parts of maximum weight coming within the limits indicated. I am aware that some electric machinery has been designed having parts of a maximum weight of 350 pounds for mule-back transport. This is suitable to regions where the altitudes to be crossed are not so great as the case indicated, and where larger and more powerful animals are available than in South America. It goes without saying that, for work of the nature I have indicated, the machines must be so simple and strong in their make-up, as to permit them to be put together by men of average intelligence, and without technical training. The machines should be capable not alone of being easily assembled, but they should also be of a nature not easily injured in the transportation or easily put out of order in the operation.

I recommend the foregoing to the attention of our manufacturers. I also commend the same to manufacturers of boilers, engines and all machinery applicable to placer and quartz mining. I am,

E. L. Zalinski,
Captain U. S. A. (Retired).

New York, August 6.

Australian Telephone Systems.

Not a single telephone system in the commonwealth is equipped with the most modern appliances, says an Australian newspaper. Of them all, perhaps, the Melbourne system, with a switchboard 30 years old in its central exchange, lags farthest behind. An interstate conference of the electrical experts attached to the several postal departments—Messrs. Jenvey (Victoria), Hesketh (Queensland), Nelson (New South Wales) and Sir Charles Todd (South Australia)—has met in Melbourne to consider how the Australian telephone system can best be standardized and placed upon a uniform basis. Each of the experts can, of course, speak with authority upon the defects of the exchanges in his own state, but, in order that all of their number may be personally acquainted with the different systems, the various capitals will be visited in turn. It will cost at least £250,000 to bring the Melbourne telephone service up to date, and for the whole commonwealth the expenditure involved in a thorough reorganization can not fall far short of £1,000,000, which it is presumed will be raised by loans.

English Engineers to Study Our Subways.

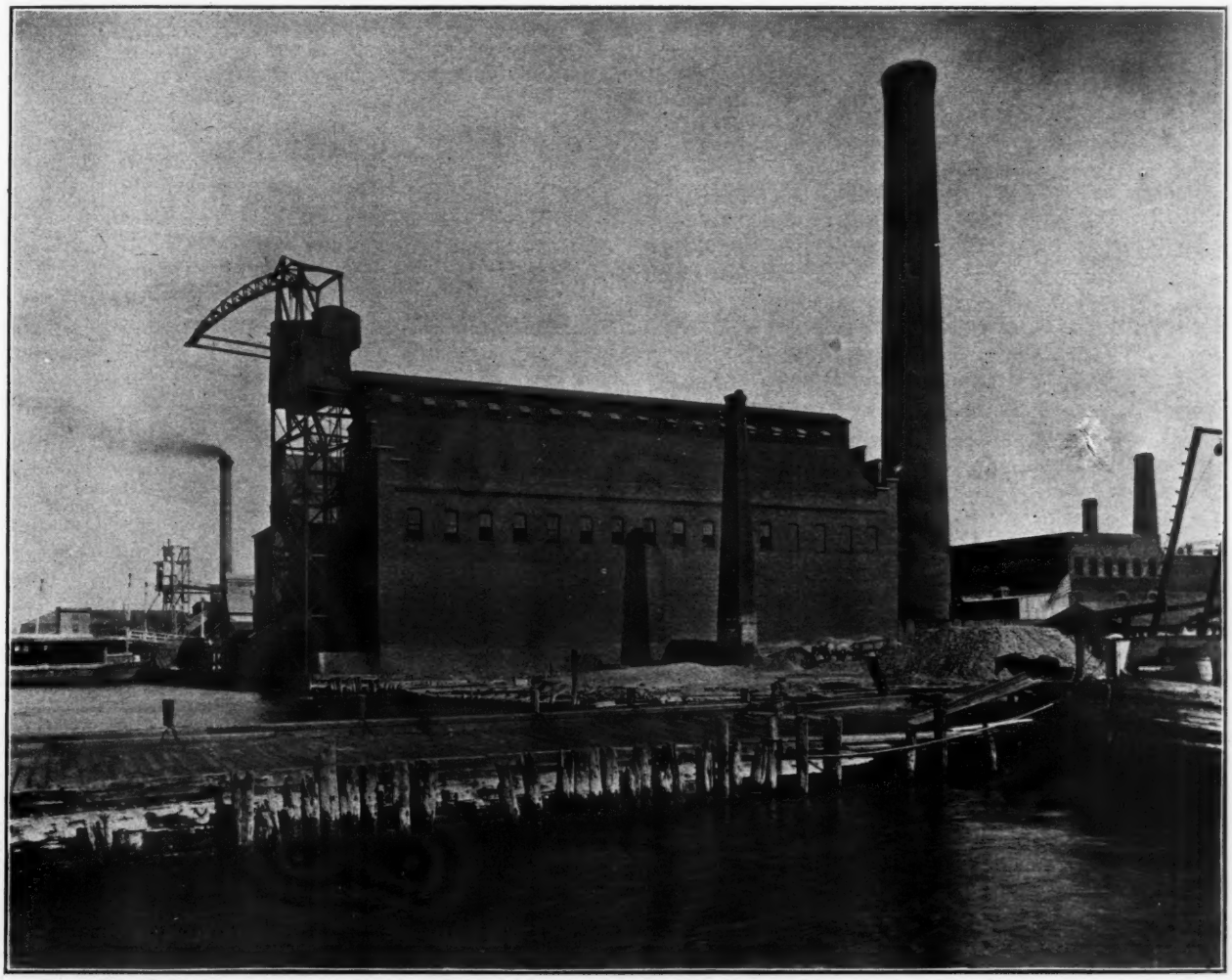
A cable despatch from London, under date of August 5, states that the president of the Board of Trade has said that the British Government was considering sending an engineer to American and Continental cities to inspect subway systems and report on their advantages over the London tubular systems.

The Kings County Station of the Edison Illuminating Company of Brooklyn.

A Highly Efficient Station Representing Standard Practice in High-Tension Generation for Distribution.

THE VERY extensive system of electric lighting operated by the Brooklyn Edison Company has been the outgrowth of years of practice in that territory and has reached its present shape from the combination of numerous scattered elements. In the general distribution of electric lighting in its territory this company uses high-tension polyphase generation from two large stations situated on the water front at points convenient for coal shipment, the current generated in these being distributed to a number of substations, where it is transformed in voltage and in character and distributed for use either as low-tension direct current or arc-lighting current used in connection with direct open-arc lamps.

It is the purpose of this paper to confine itself to a description of one of the two main generating plants—that known as the Kings County plant, and situated at the foot of Gold street on the East River.



EXTERIOR VIEW OF THE KINGS COUNTY ELECTRIC LIGHT STATION.

The station building is a rectangle, directly facing the river and accessible by Gold street, which runs along one side. It is a plain structure of red bricks, having high gable roofs, and arranged to contain, in addition to the boilers, engines and generating machinery, a considerable supply of coal. On the western side, or river front, of the station is a dock at which coal-laden boats are moored so that their cargoes may be discharged by means of automatic machinery.

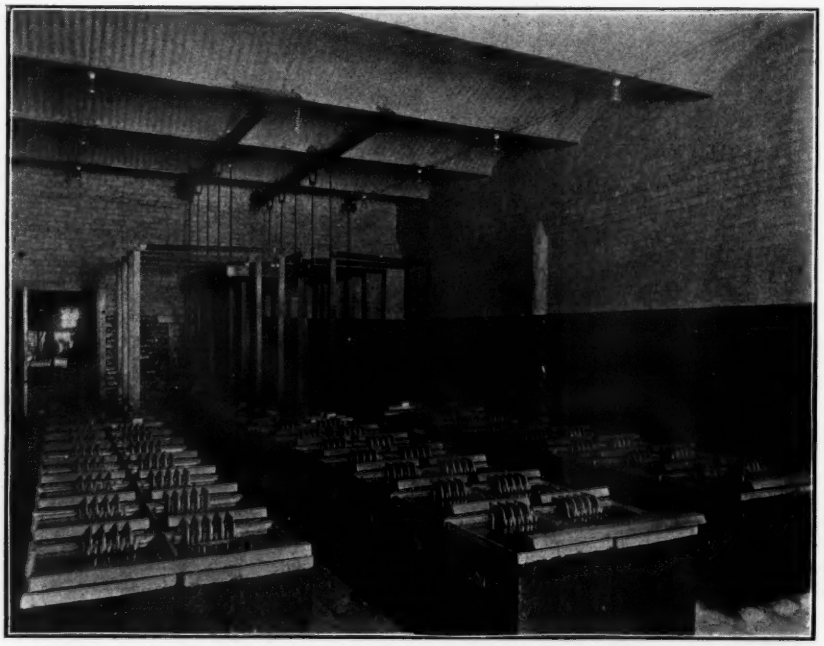
The building is divided into two parts by a heavy brick fire wall, the boilers and coal supply occupying the southern side of the structure. The crane of the coal-conveying appliance is erected so that it comes out over boats lying at the pier, and by means of buckets hoists the coal to a platform at the top of the gable roof. Here the coal is dumped into a conveyor which carries it first to a crusher, reducing the lumps so that none is larger than three inches in any dimension. This pulverization of the coal is necessary to make it flow from the chutes and to prevent its packing in any of the various automatic machines encountered in its passage through the plant. Coming from the crusher, the coal goes first into cars standing on a scale platform so that its weight may be taken, and these cars are then allowed to

run by gravity down a track over the extensive coal pockets situated above the boilers. At any point along the run a latch may be set to dump the car automatically and allow the coal to be dropped at a predetermined point. By means of a cable attached to the car, running over a sheave to a counterbalance weight, the empty car is brought back to the scale platform as soon as the coal is discharged.

THE TWO EXCITER UNITS.

The conveying and hoisting apparatus was manufactured by the C. W. Hunt Company, of Staten Island, New York city. All of the architectural ironwork of the building, including the great coal pockets, was built by the Hilton Bridge Company, of Albany, N. Y. These pockets have a capacity of 4,000 tons, and are normally kept full so that the station has a considerable reserve supply of coal to tide it over any emergency which may happen to prevent the regular reception of fuel. The weight of the coal pockets rests on the heavy brick side walls, their construction being such that the sloping sides are supported by deep plate girders of great strength, tied together at the bottom by transverse tension members.

Passing from the coal pocket, the powdered coal falls into weighing hoppers situated above the boilers, and here receives a second weighing before it is allowed to come down the chutes terminating in front of the boilers. These chutes deposit the coal directly in front of the fire doors where the stokers find it most convenient to handle it. Hand stoking is used throughout, the fuel at present in use being a mixture of five parts of anthracite pea coal to one part of pulverized West Virginia coal, run of mine. This fuel is practically smokeless, and is stated to give most excellent results in economy and satisfaction in handling, besides making a very clear, bright fire. The ashes fall into a series of ash-pits communicating with hoppers in the basement, whence the ashes can be discharged directly into cars for removal or into small cars which may be run out on the wharf and dumped into boats.



STORAGE BATTERY USED AS RESERVE AND FOR STEADYING EXCITER CURRENT.

The present installation comprises six boilers of the Stirling type, normally operated at from 150 to 160 pounds pressure. These boilers are rated at 500 horsepower each, and each is fired from three furnaces. The steam pumps, which are of the Blake pattern, are in duplicate, each being of the duplex pattern, having 12 by 7-inch cylinders with a 10-inch stroke. All of the feed water is heated by the exhaust steam from the pumps, the independent condensers and the ash-handling and blowing engines for the forced draft. The heater is of the Whitlock Coil Pipe Company's make, and steam separators made by Best, Fox & Company, of Pittsburgh, are installed in the main headers. The heater is of normally 3,000 horse-power and of the open exhaust pattern. The condensed water is not used again in this plant but is discharged into the river, it being found better economy to pay for city water than to attempt using condenser water, which always carries more or less oil with it.

Behind the battery of boilers is a steel smoke header, of rectangular section, expanding to 12 by 18 feet in size. This connects with the gigantic brick smokestack, which is perhaps the most prominent feature of the plant as viewed from the Manhattan side of the river. This stack is circular, 24 feet 6 inches in diameter outside at the bottom and 18 feet 4 inches diameter at the top, with a 13-foot circular flue. Its total height is 200 feet above the ground level. In making a foundation for it, piles were driven down to the low-water mark of the East River and upon them a stratum of strong concrete was laid; over this was built a conical foundation of rubble, carrying a coping of dressed granite 16 inches thick. The construction of the chimney itself is somewhat unusual. The outer walls of red bricks are 16 inches thick at

FRONTS OF THE BOILERS IN THE KINGS COUNTY STATION.

ONE OF THE 1,000-HORSE-POWER GENERATING UNITS IN THE KINGS COUNTY STATION.

the bottom and, of course, lean inwardly to give the chimney the proper taper. Projecting inward toward the axis of the chimney are 12 buttresses of brick, each of these being one foot thick, with a projection of three feet at the base of the chimney. The inner wall of the chimney is built just inside these, this being also 16 inches thick, and for 75 feet up being lined with a course of fire brick. An outside ladder gives access to the top of the chimney, and at the extreme flare of the top molding an 18-foot diameter ring, two and one-half by one-half inch in section, is built into the brickwork to strengthen the structure.

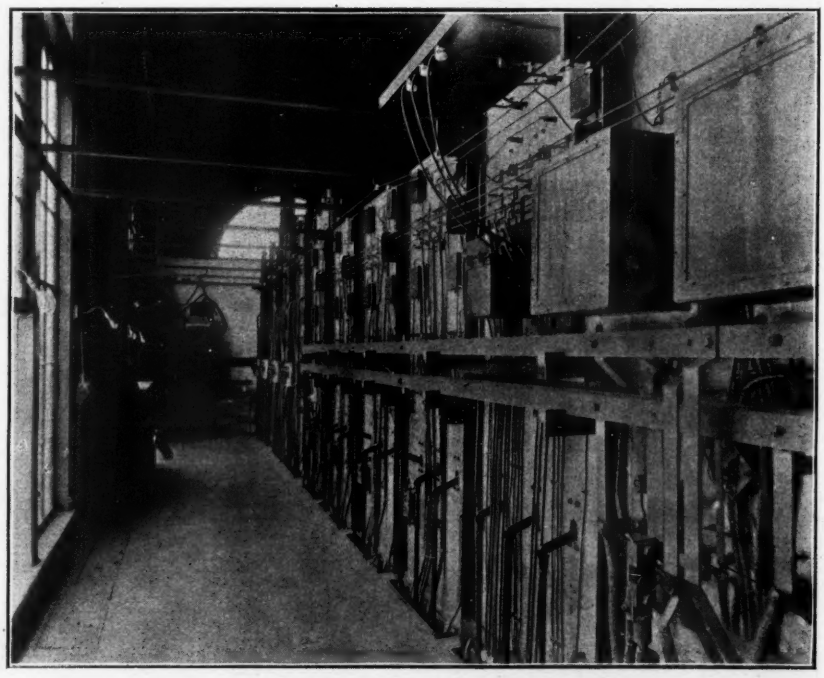
THE MAIN SWITCHBOARD ON THE ENGINE ROOM FLOOR.

For the most part the steam and exhaust piping is carried under the floor in the ample basement room provided for it. At present the engine installation consists of four main engines, direct-coupled to three-phase generators, and two small engines driving exciters. The engine room is probably one of the handsomest in existence anywhere. It is 92 by 210 feet in size, the floor being covered with granolithic pavement, and is spanned by a 25-ton crane working on rails near the top of the walls. This crane, which was built by the Case Manufacturing Company, Columbus, Ohio, is operated by General Electric direct-current motors worked from the exciter circuit, or from 125-volt current supplied by a small booster set taking current from the street low-tension mains in the neighborhood of the station. In the peak of the great roof over this room a portion, near the eastern end, has been ceiled, making a space for storage purposes, and possibly, in the future, for office purposes.

The main engines are cross-compounds of the Corliss type, built by the Edward P. Allis Company, of Milwaukee, Wis. The cylinders are 48 inches stroke, and are, respectively, 23 and 46 inches in diameter. The main shaft is 20 inches in diameter in the main bearings, which are 36 inches long. The valve gear on these machines is of the standard Reynolds-Corliss type, steam and exhaust valves being driven from separate eccentrics. Under the floor, between the two cylinders, is installed the intermediate receiver, while each engine carries a 24-foot flywheel weighing 100,000 pounds. A Monarch safety engine stop is installed in connection with each engine.

Between the two cranks of each engine is a dynamo of the revolving field type, the fields having 32 poles and the machines giving three-phase current at 6,600 volts and 25 cycles when running at a speed of 93¾ revolutions per minute. The dynamos are of the standard Westinghouse make and are rated at 750 kilowatts each. Each engine unit is provided with an independent jet condenser having a pump cylinder 32 by 12 inches, these machines being located in the basement. They are of the Blake twin vertical variety, and obtain their cold water for condensation purposes from the East River. Arrangements are also made for free exhaust when it is desirable.

Each of the two exciter units is capable of supplying all of the necessary 125-volt current for this purpose. Each consists of a Westinghouse six-pole, 80-kilowatt generator, direct-coupled with a Ball & Wood horizontal tandem-compound Corliss-valve engine. These engines have a 12-inch stroke with cylinders 7½ by 17 inches in diameter, and indicate 115 horse-power when running at their normal speed of 275 revolutions per minute. Admission valves to both cylinders are controlled by



BACK OF THE MAIN SWITCHBOARD.

RHEOSTATS AND HIGH-TENSION SWITCHES IN BASEMENT OF THE KINGS COUNTY STATION.

the governor, the exhaust valves being worked from independent eccentrics.

The circuits from the main dynamos are run under the floor and all of the high-tension switches and other apparatus for control and handling are placed in a room screened from the rest of the basement by a metallic grill. The main switchboard is on the engine room floor above this, no high-tension current being brought to the board at all. All of the handles and controlling switches are mounted on gray marble bases, the whole of the switchboard construction being of the standard General Electric type. Both fuses and magnetic circuit-breakers are used, and the switches controlling the 6,600-volt current are all of the oil-break type. The entire output of the station is led to the distributing centres by means of paper-covered cables made by the National Cable and Conduit Company and the Standard Underground Cable Company.

This station represents perhaps the extreme of simplicity in central station design and is giving its operating company the highest satisfaction on account of the great efficiency attained in its output. The design of the station is due to the New England Engineering Company, of Waterbury and New York.

Between Milan and Varese, Italy, a high-speed electric railway has recently been built. The train reaches a speed of 66 miles per hour for part of the distance, and traverses the entire distance, which is 50 miles, in 50 minutes. The third rail and four motor cars are used. The power comes from the Ticino at Tornavento.

THE MAIN ENGINE ROOM IN THE KINGS COUNTY STATION.

Electricity in Coal Mines.

The papers by Mr. Ravenshaw on the electrical transmission of power in coal mines, and Mr. Walker on electrical miners' safety lamps, which appear in the last number of the *Journal* of the Institution of Electrical Engineers, contain, with the joint discussion on the two papers, much valuable information on this comparatively recent application of electricity. The number of purposes to which electricity can be applied, either to supply an existing want or to replace some less satisfactory method, is continually increasing, and as each new problem is attacked, special difficulties present themselves. This is very apparent in this instance, where the dangers peculiar to coal mining make it essential for the electrician to design special machinery to meet the case. Mr. Walker's paper is very instructive as showing how many difficulties have to be overcome before a lamp can be obtained to compete at all successfully with the existing miner's lamp, although at first sight the electric lamp would seem to be so preeminently the best one to use. Thus, apart from questions of cost and weight, the very safety of the electrical lamp is in itself a drawback, since it does not indicate, as does an oil lamp, the presence of dangerous gases. There can be little doubt, however, that the difficulties have only to be fully realized to be successfully overcome, and in the course of time the use of electricity is likely to become general in coal mines, for which, in essential respects, it is so peculiarly suitable.

British Antarctic Expedition.

Mr. Louis Bernacchi will accompany the British Antarctic expedition as specialist in terrestrial magnetism. Ample arrangements have been made on board for special work in various departments of science; there is a magnetic observatory and biological, chemical and physical laboratories and an ample supply of instruments, and apparatus of the latest and best forms has been provided for scientific research of all kinds.

Aguinaldo's Proclamation Type.

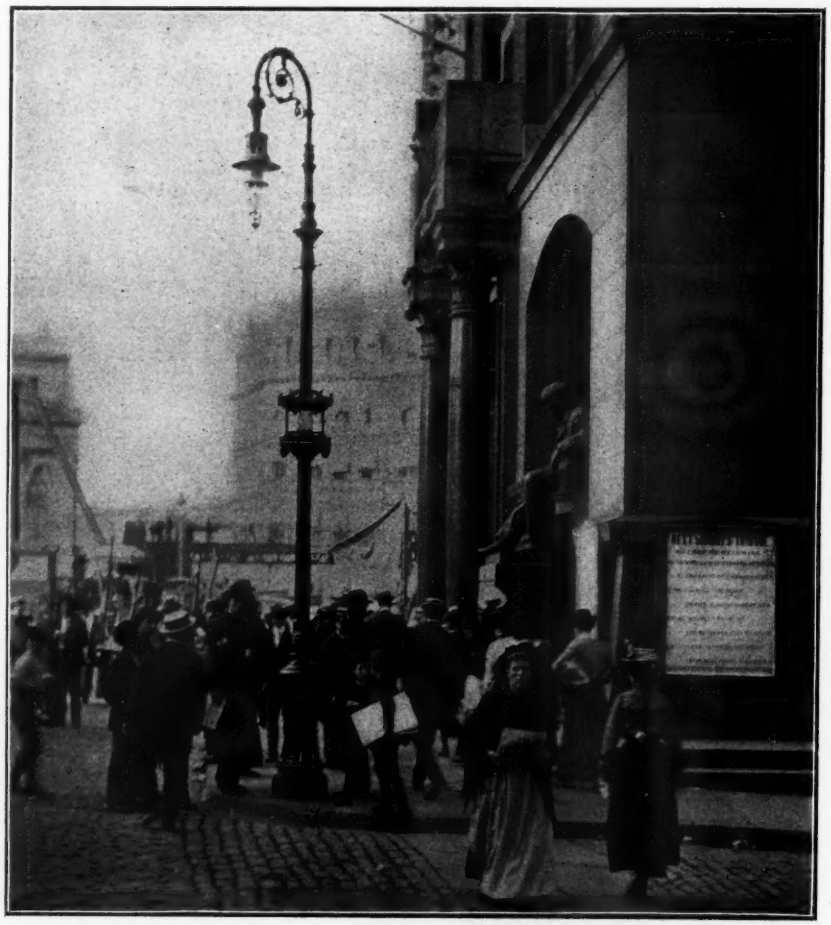
Dr. L. L. Seaman, of 18 West Thirty-first street, New York, has presented to the ELECTRICAL REVIEW a quantity of Tagalog type which he secured from Aguinaldo's camp, at San Ferman de Luzon, June 20, 1900. The hurried departure of the chief insurgent caused him to overlook his printing outfit. The type was used in printing his proclamations, and is evidently of French manufacture, and is script of good size.

The St. Louis Exposition of 1903.

The Committee on Plan and Scope of the International Exposition at St. Louis, in 1903, held to celebrate the centennial of the Louisiana Purchase, has made its initial statement concerning the enterprise. The foundation plan of the exposition will be both national and international in character, and will invite the participation of all people. The history, resources and development of the colonies and possessions of the United States will be particularly exemplified. The marked characteristics of the exposition will be life and movement, and it is expected that an ethnological exhibition of the highest order will constitute, perhaps, one of the chief features of the exposition. The plan and arrangement of the buildings and other works of architecture, sculpture and landscape gardening to be erected are so designed as to be of the highest convenience and comfort for visitors, while the transportation to and from the grounds is worked out with great detail and perfection. Electric lighting, as in the case of several recent expositions, will be one of the most attractive features of the whole, and electricity will have a large part in the exposition's work.

New Electric Street Light Fixtures and Street Signs for New York City.

The accompanying illustration shows a new type of street arc lamp fixture and illuminated street sign which the Department of Public Buildings, Lighting and Supplies is about to place in the streets of New York in considerable numbers. This first sign fixture was erected at the busy corner of Nassau and Spruce streets, just in front of the New York *Tribune* building, and its light illuminates the statue of Horace Greely, the founder of that journal. The street sign is lit by four incandescent lamps inside the glass box, making it easy to read at a distance of from 60 to 100 feet.

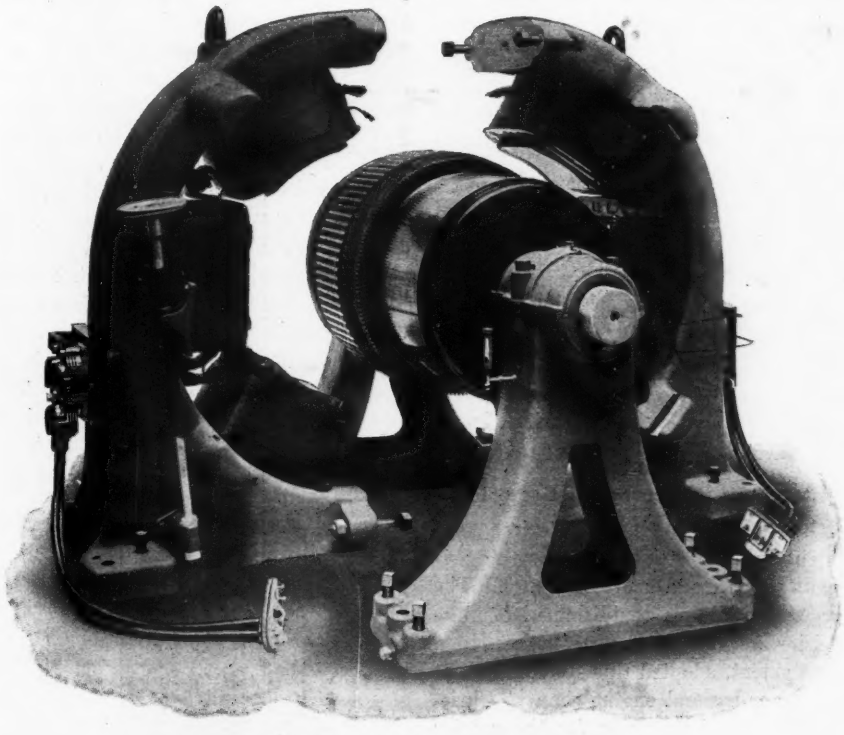


NEW TYPE OF ELECTRIC STREET LIGHT AND SIGN FOR NEW YORK CITY.
[From a Photograph by the N. Y. *Tribune*.]

In New York city an experiment is being tried in connection with the water supply for the condensing plant of the Edison company at its new electrical power-house in course of erection at Thirty-ninth street and East River. A steel tunnel, 250 feet long, measuring 12½ feet in diameter and weighing over 1,000 tons, has been built, and the intention is to sink the tunnel some 23 feet under water and to use it as a huge aqueduct to lead water from the river to the condensing plant referred to above.

New Types of Direct-Driven Generators.

In designing the generators described in this article the Western Electric Company has taken into consideration and embodied those features of its older machines which have proven satisfactory, and has made further improvements where study and experience have shown it possible.



Dynamo with Fields Moved Back from Armature.

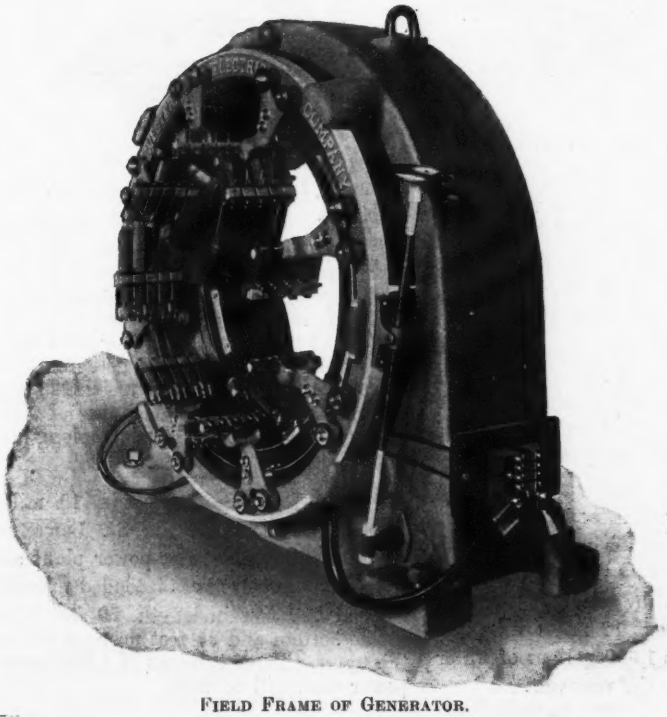
In the multipolar type of construction the generator operates very efficiently at a slow speed, thereby permitting this type to be direct-connected with engines. This is of great advantage in many installations, as economy of floor space, often a very important item, is obtained and all losses of belting and shafting and depreciation of same are eliminated.

The general design of the machine consists of a circular yoke of specially prepared metal of high magnetic permeability, having inwardly projecting pole-pieces of laminated sheet steel, thus removing practically all eddy current loss in the pole tips. The yoke is divided vertically, which permits drawing the frame apart horizontally, allowing the armature to be inspected or removed. It is also a great advantage in isolated plants of limited distance between floor and ceiling, as the frame can be easily handled without access to cranes or other lifting devices. The method of bolting the frame to the extended engine sub-base allows adjustment, both horizontally and vertically, insuring a uniform air-gap and a perfectly balanced magnetic field.

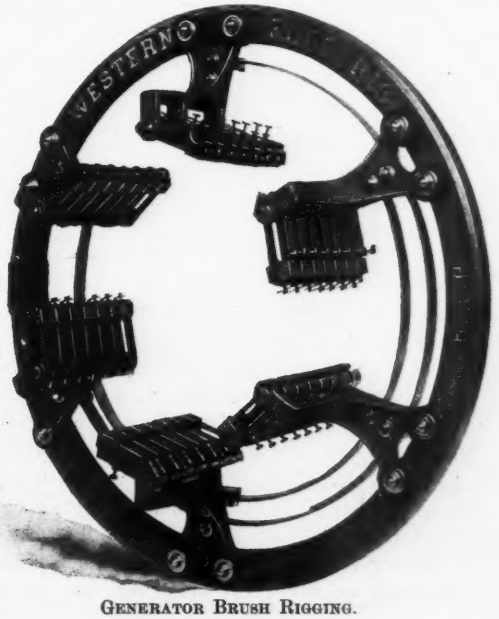
The armature is of the ironclad type. Its core is made of disks of special steel, in which the slots have been carefully punched. Radial ventilating spaces are provided, which connect with horizontal openings in the armature centre, allowing a thorough system of ventilation. In winding the armature solid bars of drawn copper are used. These bars are enlarged in cross-section at the ends of the armature, thus obtaining a very low armature resistance and a consequent gain in efficiency, while all the advantages of solid bar winding are obtained.

These bars are formed into coils before being placed on the armature so that when complete a perfectly symmetrical and balanced winding is secured. They are also insulated individually and in groups, the insulation as well as the bar itself being continuous from segment to segment of the commutator.

The armature bars are carefully insulated from each other, after which they



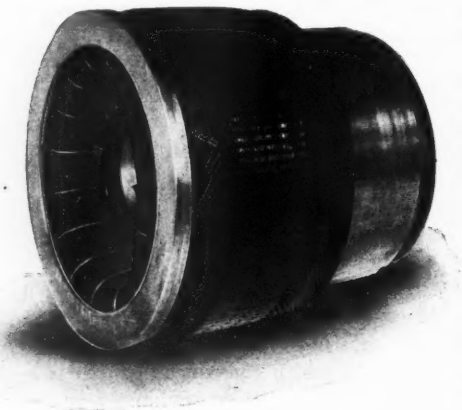
Field Frame of Generator.



Generator Brush Rigging.

are immersed in insulating compound and thoroughly baked. They are then placed in position and held by wedges; fuller board, mica and oiled paper being used to insulate them from the armature core. The engine end of the armature in the smaller sizes has a brass ring extending over and clamping the ends of the coils, thus obviating the necessity for the use of any band wires.

The commutator segments are made of hard drawn copper having rolled copper tangs. These segments are insulated from each other by specially prepared mica of a sufficient degree of hardness to produce a uniform wearing surface. The segments



Armature for Direct Driven Generator.

are mounted upon a cast-iron centre, from which they are thoroughly insulated. The completed commutator is then mounted upon the extended hub of the armature centre, thereby permitting it to be removed from the armature without disturbing the armature mounting.

One of the illustrations shows the brush-holder mounting and shifting device. Each set of brush-holders is mounted upon a brush-holder arm supported from a circular ring. This ring is carried in supports projecting from the yoke, the entire device being moved around the commutator by means of a hand-wheel at the side of the machine. This arrangement gives an extremely stable construction.

The brush-holders are designed so that the brushes may be moved in a direction radial to the surface of the commutator. Each brush is held firmly in a clamp in such a manner that the current does not pass through any sliding contacts. The current is conducted from the clamp through copper strips, thus eliminating any danger of affecting the tension springs. The brush-holder clamp and brushes themselves are small and light, and, having very little inertia, follow the commutator quickly. Any brush may be lifted from the commutator without disturbing the adjustment of the others, and all brushes may be adjusted independently.

The connection boards are of slate and are mounted on the sides of the machine. The positive and negative line terminals are provided with fuses, thereby protecting the machine from external accidents. The standard practice of the Western Electric Company is to mount the negative connection board on the left-hand side of the machine, facing the commutator, and the positive board on the right-hand side.

During the process of manufacture all parts are subjected to rigid inspection and tests and the completed machines are run for a sufficient length of time to make sure that they come within the guaranteed limits of heating, sparking, etc.

The insulation of the various parts of the machine and the completed machine are tested by the application of a high voltage, in accordance with the standard specifications adopted by the American Institute of Electrical Engineers.

Electricity in European Factories.

On the Continent, in factories, engineering shops, etc., electric working is coming more and more into use. The large shipbuilding establishment of Burmeister & Wain, Copenhagen, has, to a large extent, adopted this system, both at their foundry and engine shop at Christianshavn, and now also for the greater part of their shipyard at Refshalen. At the latter place they have built their own electric station. The engine is of 320 effective horse-power, hailing from the firm's own works, while the dynamo and motors, of which the largest is 90 horse-power, have been supplied by Siemens & Halske. While hitherto five boilers (out of seven) were in regular use, two are now, as a rule, sufficient.

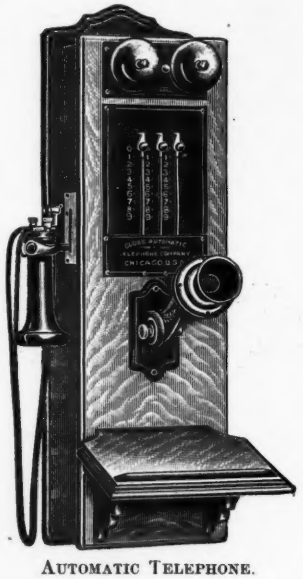
Electricity Used in Mining.

The difficulty due to lack of water for sluicing has been overcome by the Crown Mountain G. M. Company, of Dahlonega, Ga., by using electricity. It is preparing to work the ores of Crown Mountain, near the court-house of Dahlonega. Twelve miles distant is a good fall of water on the Chestatee River. Here an electric power plant has been erected. A pump station was placed on the bank of the Chestatee at the foot of Crown Mountain and a 10-inch pipe was laid to a reservoir at the summit, one mile distant and 560 feet higher. The reservoir has a capacity of 750,000 gallons. The triplex pump, driven by electricity transmitted by wire about 12 miles from the power plant, forces 1,500 gallons of water per minute up into the reservoir.

An Interesting Automatic Telephone Plant.

At the town of George, Iowa, an automatic telephone system has been installed to take the place of the manual system in operation hitherto at that point. The plant has been equipped throughout with the automatic system of the Globe Automatic Telephone Company, Chicago, and Mr. William Noll, the owner of the exchange, has given this system a thorough test in comparison with the former hand-operated switchboard. It is stated that the subscribers have increased 50 per cent since the new apparatus was installed, and that the public are well satisfied with the service, particularly as regards its secrecy and the fact that the telephones are available at any hour in the twenty-four.

The accompanying illustration shows one of the subscribers' instruments. The numbers are called by means of the key-board, each key being movable in a key-way, on the sides of which are the



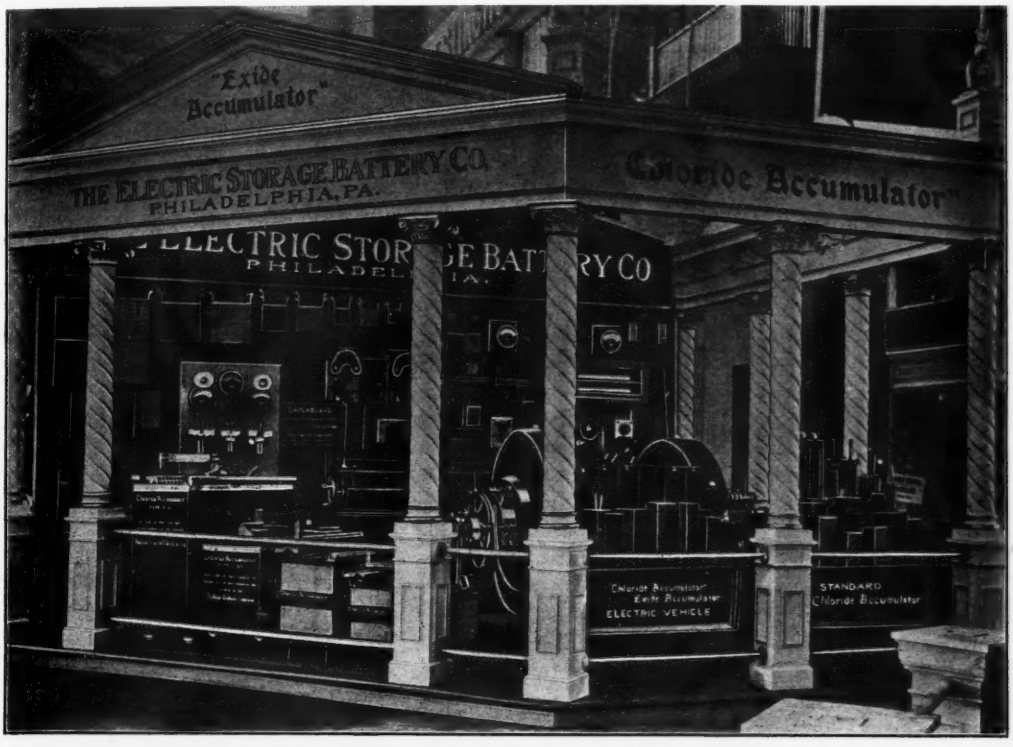
Automatic Telephone.

numerals from 0 to 9. To call No. 325, for example, the first key on the left is placed at 3, the next at 2 and the next at 5; then the receiver is taken down and conversation is held in the ordinary manner. If, however, the person wanted is talking at the time, the calling subscriber is immediately notified and no connection is made to interfere with his use of the wires. Automatic connections of this character may also be made to long-distance lines.

At the Long Sault Rapids, 10 miles west of Cornwall on the St. Lawrence River, a canal and water-power plant are to be constructed. It is intended to build a canal 200 feet in length, 50 feet wide at the bottom and 21 feet deep, to utilize the water. Three turbines of 1,000 horse-power each will be used.

The Electric Storage Battery Company's Pan-American Exhibit.

The Electric Storage Battery Company, of Philadelphia, manufacturer of the chloride accumulator and the exide accumulator, has one of the most interesting and comprehensive exhibits to be found in the electrical department of the Pan-American Exposition.

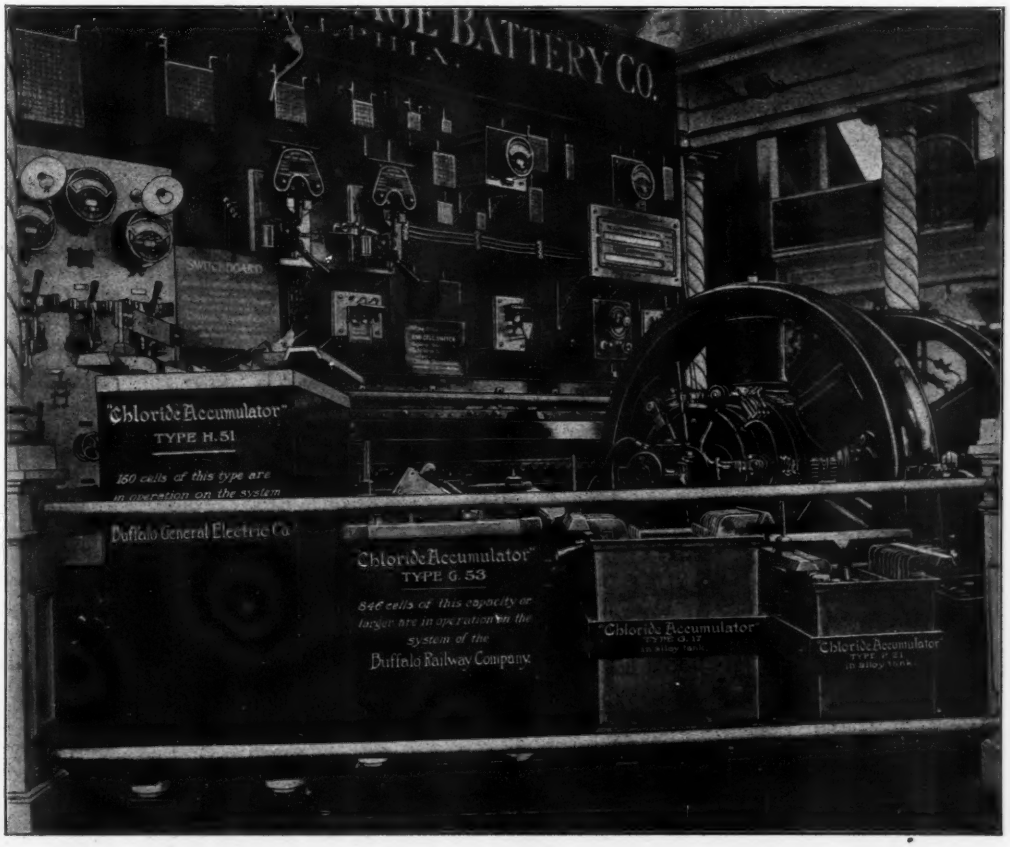


PAN-AMERICAN EXHIBIT OF THE ELECTRIC STORAGE BATTERY COMPANY.

In the central portion of the booth is placed one of the specially wound motor-driven boosters, designed by and built for the company, having an output of 800 amperes and 100 volts at full load. Alongside of this is shown a special switch for controlling the operation of the booster in connection with the charge and discharge of the battery. A 25-point, 2,000-ampere, end-cell switch-motor, driven with both electrical and mechanical indicators is exhibited, and a typical switchboard with standard apparatus and a new type of end cell switch is erected farther along this side of the enclosure.

On the opposite side are to be seen the different types of lead-lined tanks for central station, railway and miscellaneous uses. There are also shown samples of a new style of tanks which has recently been designed, known as the "all-metal" tank.

On the third side is displayed a group of some of the special types of "chloride" and "exide" accumulators, especially adapted for vehicle work, and a second group of standard chloride accumulators, adapted to the numerous applications for which these batteries are required, ranging from the smallest type, the 3-B, to the type 13-F. Special elements, designed for telephone and telegraph work, consisting of two plates cast in couplets and requiring no connector or burning to set up, and examples of cells made to meet the requirements for traction


BATTERY CO.
SWITCH BOARD
"Chloride Accumulator"
TYPE H.51
160 cells of this type are in operation on the system
Buffalo General Electric Co.
Chloride Accumulator
TYPE G. 53
846 cells of this capacity or larger are in operation on the system of the
Buffalo Railway Company
"Chloride Accumulator"
Chloride Accumulator

A CORNER IN THE ELECTRIC STORAGE BATTERY COMPANY'S PAN-AMERICAN EXHIBIT.

work, are also found in this section. Among the cells exhibited is one of a size used very largely in heavy railway service. The Metropolitan Street Railway Company, of New York, operates nine batteries, aggregating 2,742 cells of this type, and the Buffalo Street Railway Company has in service three batteries, with a total of 846 of these cells, representing an output of 7,276 kilowatt-hours.

Among the central station cells shown is one of type H-51; the Buffalo General Electric Company operates 150 cells of this type, with an output of 2,336 kilowatt-hours. The display is most interesting to electrical engineers, as illustrating the type of storage battery construction developed by years of this company's experience.

The number of batteries of chloride accumulators installed in Buffalo by the Electric Storage Battery Company enable the company to show visitors who are interested installations in various classes of service in daily operation. To facilitate the inspection of these plants the company issues passes to visitors applying for them. Managers of railway and lighting companies, engineers, etc., are thus afforded an opportunity to investigate the workings of the accumulator in commercial operation.

The company has issued for distribution from its exhibit an interesting illustrated bulletin, giving in brief outline many different applications of its accumulator to central station, electric railway, miscellaneous lighting and power uses, etc.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA.

PROCEEDINGS OF THE SECOND ANNUAL CONVENTION, HELD AT NEW ALBANY, IND., AUGUST 1 AND 2, 1901.

The second annual convention of the Independent Telephone Association of Southern Indiana was held in Maennerchor Hall, in the city of New Albany, Thursday and Friday, August 1 and 2. The convention was called to order at 2 P. M. by Mr. G. A. Kienle, president of the association, and an address of welcome was delivered by the Hon. C. D. Knoefel, president of the Home Telephone Company, of New Albany. A communication from the Hon. S. P. Sheerin was read by the secretary, and a communication from the Hon. H. B. Gates, the secretary of the Indiana Mutual Association, was also read, both being received with acclamation. The first paper on the programme was on the subject of "Independent Telephone Promotion," and was read by Hon. E. M. Coleman, secretary of the Home Telephone Company, of Louisville, Ky.

Mr. Coleman's address was of a very thoughtful and interesting nature. It dealt with the effect of the patent laws and the counter-effect of monopoly upon the status of the art. Mr. Coleman upheld the reputation of promoters, who, he said, are truly benefactors to the general public. He went on to state the problem confronting the promoter in each case, his difficulty in creating public sentiment and securing financial backing, and then the inevitable fight with the older organization. His paper contained a great deal of practical and sensible advice, and closed with a statement of the independent situation in Louisville. The independent company there would begin business, he said, early next year with more than 5,000 subscribers. His paper was discussed at length by Messrs. Knoefel, Kienle, Landgrebe, Zeluff, Kusel and Davis.

The second paper on the programme was read by Mr. George Borgerding, of New Albany, and was entitled "The Bell *versus* the Independent Telephone System." This paper was an historical account of the rise of the telephone industry in the United States and of the causes which led up to the formation of independent companies and the movement which bears their name. A number of typical instances were quoted, and the whole subject of telephony in its relation to the public entered into at length. Particular attention was paid by the author to the party-line problem. He recited the experience of the New Albany company and of other companies in Indiana.

The discussion was participated in by Messrs. Kusel and Coleman. After some formal business, the day's session adjourned to meet the following morning.

In the evening a reception was tendered the delegates and visitors by the officers of the Home Telephone Company, of New Albany. Covers were laid for 100 guests in the hall, and Mr. Knoefel acted as toastmaster. A large number of speeches, many of them of great interest, were made, and everybody present had a good time and enjoyed himself.

The second day's session was called to order promptly at 9 A. M. by the president. The first paper read was by Mr. Phillip Dilley, of Huntingburg, Ind., and was entitled "Free Service—Ought There Not to Be a Limit?" Mr. Dilley took the position that entirely too much free service is being given by telephone companies in general, and that there ought to be a limit. He spoke of the practice of the general public in trying to beat the telephone company whenever possible, and showed how the permission of this practice worked to the detriment of the exchange service. The discussion of the paper was led by Mr. T. M. Thom, and participated in by Messrs. Knoefel, Davis, Beaucond and others.

The next paper, on the interesting subject "Is It Profitable to Furnish Telephone Service at Fifty Cents per Month?" was read by Mr. J. W. Ladd. Mr. Ladd argued to show that it was practically impossible to maintain any kind of service at this price, although it is possible to demonstrate on paper that such a price would pay the expenses of an exchange; yet in practice it is found that it does not, and the too great cheapening of service which has been indulged in so largely by independent companies has not been beneficial to the art in general. Mr. Ladd's paper was a valuable and able presentation of the argument for more reasonable prices for service. He spoke at length of farmers' systems and toll-line systems running through the country. The paper was the subject of an extended discussion.

The next paper was read by Mr. L. G. Davis, and was entitled "Farmers' Lines—How to Make Them Profitable to the Local Exchange." Mr. Davis spoke of the increasing use of the telephone by the agricultural population and of the demand for connection between farmer and town, which has been discovered by the extension of country lines. While Mr. Davis's paper was quite short, it contained a well worked out idea for a method of establishing farmers' lines, and was listened to with great interest. A number of those present discussed the paper at some length.

The next paper was read by Mr. C. F. Stevens, and was entitled "The Benefits of Metallic Lines as Compared with the Grounded System." This paper was somewhat technical in character and was a strong argument in favor of full metallic circuits.

A vote of thanks to the local telephone company and its officers was then passed, and the treasurer's report was read. The next business was the election of officers, and this resulted as follows:

President, G. A. Kienle, Huntingburg; vice-president, C. D. Knoefel, New Albany; secretary, E. W. Pickhardt, Huntingburg; treasurer, T. M. Thom, Lamar.

It was then resolved to hold a joint meeting in conjunction with the Kentucky Telephone Association in Louisville some time in January or February, 1902, and, after various further votes of thanks and formal business, the convention adjourned.

Current Electrical News

COMMERCIAL NEWS

DOMESTIC AND EXPORT

Sir Cavendish Boyle, the Governor of Newfoundland, has announced that the Marconi system of wireless telegraphy will be installed at an early date along the Labrador coast.

An important consolidation of surface railway interests in the vicinity of Troy, N. Y., has just been consummated. This company will have a capital of $2,600,000, and will be known as the Hudson Valley Railroad Company.

News comes from Montreal that the British wire to Dawson City, Alaska, will not be in operation for a month yet. The portion of the line now under construction passes through very difficult country and therefore it may be even later than the end of August before it is completed.

Prominent Boston financiers are engaged in an enterprise to build an electric road from Providence, R. I., to Boston, Mass. This line will run through Hyde Park, Mansfield, Canton, Sharon, and East Foxboro. It is said that the highways will not be used, the idea being to run electric express trains from town to town.

A new and more direct telephone line has been opened up from Atlanta, Ga., to New York city. The previous telephone routes have been shortened by 150 miles. Rates have been reduced from $10 to $5.75 during the day and $2.99 at night for three-minute tolls. There are now three telephone circuits from Atlanta all the way through to New York.

The new power plant of the Citizens' Light and Power Company, of Rochester, N. Y., will be constructed by A. Friederich & Company, of Rochester. The work of excavation has already been completed. No figures were given out as to the detailed contracts, but it is stated that the aggregate cost of the new plant with its equipment will be nearly $2,000,000.

The Metropolitan District Electric Traction Company, Limited, which was recently incorporated under the British Limited Liability Acts with a capital of £1,000,000, mainly with a view to undertaking the contract for the electrical conversion of the Metropolitan District Railway of London, is composed mainly of some 30 Americans and American concerns. They control 46,750 out of the 50,000 shares.

An open car without a roof has been put in operation upon the surface lines of the Transit Company, of St. Louis, Mo. This car will be run only at night when no rain threatens, and will be much like a huge automobile. The cords by which the conductor signals the motorman run along the footboards instead of overhead, and the only lights used are a bunch-light with a reflector at the rear end of the car. It is intended for pleasure rides.

A company known as the Consolidated Street Railroad Company will soon be incorporated in Utica, N. Y. This is the nucleus of a gigantic electric railway system in central New York. Its object is to compete for passenger traffic with the steam roads and the American Express Company. The new company will be capitalized at $3,500,000. It is represented by Horace E. Andrews, of Cleveland, Ohio, and A. M. Young, of New York, who have a number of New York capitalists associated with them.

The committee on transportation of the city council of Chicago, Ill., is considering a plan for offering to the highest bidder in the open market the next street railway franchise which it grants. It is expected that the specifications will be ready by the middle of October. It is estimated by Mayor Harrison that a 20-year franchise, such as the Union Traction Company now holds, is worth at least $24,000,000, and he believes that the present companies should be given first consideration in disposing of such a franchise.

Some adverse comment is being caused by the proposed electric lighting of the Yosemite Falls, on the grounds that it is a desecration of the natural charms of this California wonderland. Mr. Corey, the engineer of the commission, is preparing for bids for four searchlights, so placed as to light the falls from top to bottom and also for the placing of about 700 incandescent lights in and about the hotels and cottages. He claims that this will in no way interfere with the scenic effects, but will rather add to the comfort of the visitors.

What is claimed to be the largest private electric lighting plant in the country is being completed for the Illinois Central Railroad. It will furnish illumination along the entire right of way from Chicago to Matteson, Ind., a distance of 28 miles. It will also supply light and heat to all the depots and freight houses, besides operating the company's laundry, passenger elevators in Chicago, and charging storage batteries for private cars. There will be in all 14,000 incandescent and 500 arc lights used. The right of way of this railway will be the best lighted in the world.

Mr. Nikola Tesla's first wireless telegraph station, it is stated, will be built at Wardenclyffe, L. I. Two hundred acres of land on the shore of Long Island Sound have just been purchased, and the work of putting up the necessary buildings will soon begin. The main building is to be 100 feet square, and will be occupied by an electric plant of 350 horse-power. It is estimated that the cost of this part of the plant will be nearly $150,000. The Wardenclyffe station is to be the main one of the system, and Mr. Tesla states that he expects to be able to communicate with all parts of the world from that point.

A. W. Lawson, the veteran baseball manager, is in Seneca Falls, N. Y., superintending the construction of a portable electric lighting plant. He intends to furnish lights for baseball games played in the evening. His machine includes an engine, boiler and dynamo, having a capacity sufficient to supply 20 arc lights, all of which are carried upon a specially constructed truck. There are also poles, wires and other appliances which go to make a complete lighting plant. The plant was recently given a test where a game of baseball was played between two picked nines. Mr. Lawson was highly satisfied with the result, and is looking forward to a successful season.

General Mason, United States Consul at Berlin, Germany, reports that the published newspaper statements to the effect that new electric trains have been running at the rate of 125 miles an hour between Berlin and Hamburg is considerably exaggerated. He says that a series of high-speed trials aided by the German Government is to be made on an 18-mile line between Berlin and Zossen in August and September, which will attract great attention among the electricians of the world. A special motor-car has been built by the Allegemeine Electricitäts Gesellschaft, which is to run in competition with one made by one of the leading American concerns for this special test.

The work upon the 160-foot mast at Siasconsett, Mass., for the wireless telegraph system has been completed. The main mast, which is eight feet high, has been raised and is strongly guyed with two and one-quarter inch wire rope attached to heavy sand anchors. The guys from the topgallantmast for electrical reasons are of tarred rope. The ground connections were made by placing 80 heavy metallic plates two and one-half by eight feet in the ground at the rear of the operator's house. Over 100 cells will be used to furnish electrical power, and four accumulators have been placed in the operator's room. Messrs. Lockyer and Bradfield have left for the South Shoal Lightship to install the plant upon that vessel. Commander J. D. Kelly, U. S. N., intends to have the service open to the public, if desired.

The capitalists who are behind the recently organized Interstate Telephone Company of New Jersey have acquired control of the Consolidated Telephone Company of Pennsylvania, which was formerly the Schuylkill Telephone Company. This company has also taken over control of the Paterson, Passaic & Suburban line which has 2,000 telephones. The secretary of both the Interstate and Consolidated companies, Mr. A. M. Worstall, says that they will be operated in close connection with the Keystone Telephone Company, of Philadelphia, under long-term interchange contracts. The capital of the Consolidated company has been increased to $4,000,000, and an issue of $6,000,000 in bonds authorized. A considerable part of the capital and bonds will be used in merging into the Consolidated the independent lines of eastern Pennsylvania, which have 11,500 telephones.

The president and general manager of the Mobile Light and Railroad Company, Mr. J. Howard Wilson, has stated that the consolidation of the Mobile Light and Railroad Company, the Electric Lighting Company, of Mobile, and the Mobile Gas, Light and Coke Company will take place September 1. The consolidated company will adopt the name and charter of the Mobile Light and Railroad Company, and the amount of capital stock and bonds to be issued by the consolidated company will be fixed at the time of consolidation September 1. Great improvements will be made, the tracks will be relaid with heavy rails and a number of new cars will be built. The new power plant at the corner of Water and Monroe streets will be enlarged by the addition of large engines and generators. Wherever the company can afford it underground conduits will be constructed for the electric wires.

Active work has been begun by the California Power Company upon its great enterprise of developing electric power from the Kern River, with a view of transmitting it to the cities of southern California. Chief Engineer Finkle has taken a force of men to the mouth of the river and is actively engaged in the work of construction. The preliminary work consists of building a two-mile stretch of road up to the mouth of the Kern River canyon, and when this is finished the work of diverting the waters of the river through the mountains by a score of tunnels, ranging in length from 400 to 5,000 feet, will be taken up. The company expects to obtain a waterfall of over 800 feet. Two years will be required to complete the tunnels and power-house. About $2,000,000 will be expended in the work, from which the company expects to derive about 15,000 horse-power which will be carried to Los Angeles, 100 miles away. It is the intention, ultimately, to develop 45,000 horse-power by the construction of additional power-houses.

ELECTRICAL SECURITIES

There was a distinct improvement in the tone of the market for securities during the week ending August 10. Although prices did not materially advance, this improvement could be traced to changes in the agricultural and industrial situation. The drought has been broken and favorable crop conditions are now prevailing all over the country. A much more hopeful feeling as to the outcome of the steel strike was prevalent. The total transactions for the week averaged very small, the stocks of largest activity being Steel common and preferred, Union Pacific, Southern Pacific and Atchison.

A general feeling of confidence seems to pervade the air, and business conditions throughout the country are so good that the feeling of confidence is greatly restored. Notwithstanding the labor troubles and the partial corn crop failure in the Middle West, the country at large is doing well, and this fact is having its natural effect upon the market.

The week closed with money in a firm position. There is still more or less hesitancy in putting out funds on long time, caused by the fact that banks are already well loaned up, and because the season is near at hand when demands from the West and South will have to be met.

ELECTRICAL SECURITIES FOR WEEK ENDING AUGUST 10.

New York:	Highest.	Lowest.	Closing.
Brooklyn R. T....	75½	72⅝	73¼
Con. Gas.....	221	217	218½
Gen. Elec.....	252½	246½	249½
Man. El.....	117½	114¼	116¼
Met. St. Ry.....	166	163	164¼
Kings Co. Elec....	...	...	197
N.Y. & N.J.Tel.Co.	...	...	175
Telep.,Tel.&Cbl.Co.	...	...	3

A sheriff has taken charge of the General Carriage Company under an attachment for $41,000. The company will probably be reorganized.

Inside sentiment on Brooklyn Rapid Transit continues bullish. There was some liquidation, it is claimed, by the political element which suffered in the Graeff failure. This liquidation is believed now to be over.

Boston, August 10:	Closing.
Am. Telep. & Tel.....	160¼
Erie Tel.....	47½
New Eng. Tel.....	140
Mass. Elec. pf.....	93
Westing. Mfg. pf.....	79½
Edison Elec.....	260

A dividend of $1.50 per share on the stock of the New England Telephone and Telegraph Company was paid August 15.

Philadelphia, August 10:	Closing.
Elec. Co. of Amer.....	7⅛
Philadelphia Elec.....	5¼
Union Traction.....	26½
United G. I. Co.....	115
Elec. Stor. Bat. c.....	75
Elec. Stor. Bat. pf.....	75

A director of the Electric Storage Battery Company says that no proposition from the General Electric Company has come before the board, and he is not cognizant of any overtures looking to a merger or otherwise. He adds, however, that it would seem natural enough for the Storage company and the General Electric Company to be very closely related some time or other in the future.

Chicago, August 10:	Closing.
Chicago Edison Light.....	168
Central Union Telephone.....	45
Chicago Telephone.....	275
Un. Trac.....	15½
Un. Trac. pf.....	58
Metropolitan El.....	92½

The dividend of one and three-quarters per cent on the preferred stock of the National Carbon Company was paid August 15. Books reopened on August 16.

PERSONAL MENTION

MR. CYRUS O. BAKER, the well-known platinum importer of New York city, is sojourning on the Pacific coast.

MR. JAMES S. HEALEY has accepted a position with the Century Telephone Company, of Cleveland, Ohio, to act for the company in the capacity of traveling electrician. Mr. Healey heretofore has been connected with several telephone manufacturing companies and is well known throughout the telephone field.

MR. F. A. ESTEP, president of the street-car supply house of R. D. Nuttall Company, Pittsburgh, Pa., has sailed for Europe on a business trip. Mr. Estep will establish while abroad several additional agencies for the sale of his company's specialties in various parts of Continental Europe. The Nuttall Company is now filling orders for Great Britain, the Netherlands and Italy.

MR. H. A. LOUD, the managing director of the British Westinghouse Electric and Manufacturing Company, has just returned from a trip to Europe, where he went for the purpose of inspecting the progress in the construction of the new Manchester plant and conferring with the English interests of the company regarding the placing of the equipment contracts. Mr. Loud is now in Pittsburgh.

MR. T. F. HUNTER, who was formerly actively engaged in the electrical supply business in New York, has returned to that city from Jacksonville, Fla. He is now associated with H. M. Shaw & Company as salesman. Mr. Hunter has thoroughly familiarized himself with present conditions in the South, and is prepared to answer any questions regarding machinery, tools and supplies for railways, power plants, etc., for the southern market.

MR. W. B. McCURDY, eastern manager of the American Electric Fuse Company, has recently accepted the general eastern management of the International Specialty Company, of New York, Chicago, and San Francisco, whose eastern offices and salesrooms are at 110 to 116 Nassau street, New York city. The company promises some agreeable surprises in the improvements recently made on its telephones and apparatus, and is also in a position to manufacture all kinds of wood and metal specialties. Mr. McCurdy has built up a very successful business for the American Electric Fuse Company in the East and South, and at the solicitation of the board of directors will continue to manage the eastern business of the Fuse company.

LEGAL NOTES

THE NEW YORK COURT recently held in the case of Jacobs against the Third Avenue Railroad Company, that a street car railway company is not liable for ejecting a passenger who presents a transfer from a connecting line, which was not acceptable under the rules of the company, where a mistake in issuing said transfer was made by an employé of the connecting road; there being no community of enterprise between the two companies, and the business of each being independent.

In a somewhat similar case in Illinois a plaintiff having received from a street car conductor a wrong transfer slip, boarded a car on a connecting line, tendered the transfer, which the conductor refused, and declined to pay her fare. The conductor then requested her to leave the car. This she refused to do and reasonable force was used to eject her. The court held that the plaintiff could not recover for any injury sustained as it was her duty to peaceably leave the car and appeal to the courts for redress.

AUTOMOBILE NOTES

Secretary Butler, of the Automobile Club of America, has received three notable entries for the automobile race from Buffalo to Erie. M. Henri Fournier, winner of the big Paris-Berlin race, as well as the contest to Bordeaux, Jockey Tod Sloan, and M. Charron, who is considered second only to Fournier in skillful manipulation of automobiles, will take part.

Arrangements are now being made for the automobile test between New York and Buffalo, which will commence October 9. The average stages are from 88 to 90 miles. The total distance to Buffalo is 500 miles. Great care is being used in the selection of the route that it may include all conditions of roads likely to be met with in the general tour of the state. The regulations for it are now being prepared.

The law enacted by the State Legislature of Connecticut at its last session regarding automobiles went into effect August 1. By this law the speed of all power vehicles is limited to 12 miles per hour in the cities and 15 miles per hour on the country roads. Moreover, if the driver of horses, when meeting an automobile, holds up his hand the *chauffeur* must stop instantly. For violation of this law a penalty of not more than $200 is attached.

Mr. and Mrs. Harry Decker, of New York, have left the Gilsey House en route to Texas, with the intention of covering every mile of the way on an automobile. The itinerary was arranged for them, but as the map did not arrive in time Mrs. Decker decided not to wait for it and mapped out a route on a map of the United States. They will travel from town to town and will decide how to proceed from each city and village. It is their theory that the residents of each locality will be able to tell them more concerning the route than any map-maker could possibly know, and they will be able by this method to see more of the country than in any other way.

The Deering Harvester Company, of Chicago, Ill., has been building an automobile grass mower. It is propelled by a four-horse-power gasoline motor, and is said to have cut 22 acres in nine hours, using a five-foot sickle bar. The motor is placed in front of the driver's seat and rests upon a leading third wheel, and the cutter bar is at the side, as is usual in machines drawn by horses. The traditions of horse-mowing machines have been followed very closely. The cutter bar could have been placed directly in front of the machine since there are no horses to tread upon the grass, and the driver could be given a higher seat where he would have a better view of the ground. By this construction the machine would be simplified and would probably be lighter, while the cutter bar would be more manageable and subject to less jar and strain than when carried out at one side.

A curious accident happened to Mr. S. F. Edge, who was the only English competitor in the Paris-Berlin motor race, which rendered it impossible for him to continue further. He was driving a 70-horse-power Napier car. It traveled splendidly and prior to his first puncture he had drawn up from twenty-fifth position, where he had started, to ninth. In the first 50 miles his tires were punctured no less than seven times, the final accident causing his retirement while passing a competitor. Owing to an immense cloud of dust he could not see his way, and while traveling at the rate of 70 miles per hour he struck the arched curve of the road over a bridge. The car leaped into the air and bounced back into the road again like an india-rubber ball. Under the impact the back carriage spring broke, and, as it would have required two days to replace it, Mr. Edge was compelled to withdraw from the race.

TELEPHONE AND TELEGRAPH

The bonded indebtedness of the Dauphin County Telephone Company, of Harrisburg, Pa., will be made $300,000.

In Sidney, Ill., the Home Telephone Company is extending its lines. It will also make improvements to the extent of $1,000.

The lines of the Williamstown & Owenton, Ky., Telephone Company will be extended from Falmouth to Boyd to connect with the Cynthiana system.

Mr. Phillip Fitzsimmons has conveyed to the Fitzsimmons Telephone Manufacturing Company, of Cincinnati, Ohio, all his rights to use the streets of the city for telephone purposes.

The Cumberland Telephone Company, Lake Providence, La., now has 80 telephones in operation in that town. The company will at once erect a long-distance line to Tallulah, with a view of connecting later with St. Joseph, La.

The Consolidated Telephone, Telegraph and Cable Company, Cleveland, Ohio, has elected the following officers: President, B. G. Hubbell; first vice-president, W. H. Price; second vice-president, R. N. Parmley; secretary and treasurer, J. H. Fuller.

The New York Telephone Company is about to erect a special building for its exchange at Yonkers, N. Y., in view of the rapid increase there. The new building will have a front of 60 feet and a depth of 90 feet. It will be four stories high.

The local telephone exchange at Elberton, Ga., has been purchased by the Southern Bell Telephone and Telegraph Company. It will immediately begin the construction of a new exchange and modern long-distance toll-service line between Atlanta and Elberton.

A special committee was recently appointed in San Antonio, Tex., to investigate and suggest a remedy for the overhead wires. It has recommended to the city council that all telephone, telegraph and electric wires within the city limits be put underground.

Extensive improvements are being made upon the lines of the Cumberland Telephone Company, of Tennessee. Two new lines are being established which will greatly facilitate the business and result in greatly increased convenience for the patrons. Dr. Eugene Logan is the company's manager in Nashville, Tenn.

The Maryland Telephone and Telegraph Company by its contract with the War Department will soon begin the construction of a line to establish telephone connection between Forts Howard, Armistead and McHenry, at the entrance to Baltimore Harbor, and all points served by the company's lines.

It is reported that the Central Pennsylvania Telephone Company, of Scranton, Pa., and the Pennsylvania Telephone Company, of Harrisburg, will become a part of a combination formed at Reading, to be known as the Consolidated Telephone for Pennsylvania. Mr. Richard Bryan, of Scranton, has been chosen general manager of the new company.

The Southern Bell Telephone and Telegraph Company will soon erect a fine new building in Atlanta, Ga. It will adjoin the present exchange corner Prior and Mitchell streets, and will have a frontage of about 40 feet with a depth of about 100 feet. Bleckley & Tyler are the architects for this new addition. It is to cost about $40,000. The contract has not yet been let, but will be in a few days, when the work will begin at once.

ELECTRIC RAILWAYS

A certificate of the Greenwich & Schuylerville Electric Railway Company has been filed with the Secretary of State.

The Oneida Railway Company, of Oneida, N. Y., has had its engineering force resume the survey for the extension of its lines.

Mr. W. H. Bourdhart, of Salem, Ore., has asked the County Court for a franchise for an electric railway from Salem to Silverton, a distance of 15 miles.

The residents of Rotterdam, N. Y., have signified their desire in a public meeting to grant permission to the Schenectady Railway Company to extend its lines through the town.

The Pacific Electric Railroad, of Los Angeles, Cal., has been incorporated in Arizona to construct feeders into Long Beach and Monrovia. The Huntington-Silmore Syndicate will control the company.

Those interested in the Suffield Street Railway Company, of Suffield, Ct., have effected an organization for their proposed route, six miles in length, for which a franchise has already been secured.

Citizens of Carlisle, Pa., have received charters for two more trolley roads. The first was the Star Street Railway Company, which is three miles long; the second road will run through New Cumberland to Lewisburg, a distance of seven miles.

Applications for permission to make extensive improvements in its system of tracks will be asked for by the Atlanta Railway and Power Company, of Atlanta, Ga., from the city council. The company also desires to make a number of extensions in its lines.

It is rumored that the companies who are interested in the paying up of the Oneida, Utica & Herkimer and the Frankfort & Ilion street railway lines, are to purchase the franchise of the Rome City Street Railway Company, which is now controlled by New York parties.

The State street route for the East Boston tunnel has been decided upon by the Boston Transit Commission instead of the Fleet and Hanover streets route as was first proposed. This route will furnish a better connection with the elevated railway system.

The Hartford & Springfield Street Railway Company has begun to push work on its new line between Warehouse Point and East Windsor Hill, Ct. This road when completed will be one of the best equipped and will have one of the finest road-beds of any trolley line in New England.

The work upon the Beloit, Janesville & Delavan Lake Electric Railway Company, of Janesville, Wis., has been begun by Hayes Brothers. The work of grading will be commenced at several points between Beloit and Rockford. They are sure that they can complete the work within the time limit, which is January 1, 1902.

L. H. Lancaster, of Thibodaux, La., states that the preliminary surveys for the Lafourche & Terrebonne Railway, an electric line have been completed and that the rights of way will soon be secured. The contracts will be let October 1. The line will be 70 miles long, running from Houma to Donaldsonville. C. P. Young is chief engineer.

The president of the Kansas City & Olathe Electric Railway, of Kansas City, Mo., Mr. F. C. Goodwin, says that some contracts for grading, etc., have been let, and that the company would like to hear from contractors experienced in building routes of this character who can also assist in financing the same. The company has its franchise, rights of way and a portion of its capital.

ELECTRIC LIGHTING

The city of Alameda, Cal., is to improve its electric lighting plant at a cost of about $10,000.

Bids for constructing an electric lighting plant in Greenwood, Miss., were received until August 16.

Messrs. Collier and Brown, engineers of Atlanta, Ga., are to build an electric lighting plant in Starke, Fla.

The city of Chillicothe, Ill., asked for bids a few days ago, for lighting the city for two years or longer, at the option of the city, from October 1.

The Missouri Power Company, of Helena, Mont., will begin the construction of its proposed power plant in October. The estimated cost is about $600,000.

The general manager of the Washington Power Company, Spokane, Wash., Mr. D. L. Huntington, states that it will be some time before the plans are available for the new plant to be erected.

In Conneaut, Ohio, an election will soon take place to settle the question of issuing $20,000 worth of four per cent bonds for the improvement of the electric lighting plant. Mr. W. F. Stanley is mayor.

The Yosemite Valley Commission of San Francisco, Cal., are asking for bids for constructing an electric light plant in the valley to cost about $30,000. Professor Corey, of the University of California, is the engineer.

On August 6 the Oshkosh Electric Light and Power Company, of Oshkosh, Wis., was reorganized and steps were then taken to rebuild the plant at a cost of about $60,000. Messrs. A. E. Thompson and Leander Choate are interested.

Rumor has it that Messrs. Finch and Campbell, of Port Falls, Idaho, propose to build an electric lighting plant for the Coeur d' Alene mines to cost $1,000,000. The power will be carried about 65 miles. R. K. Neill will have charge of the works.

The Council and Board of Trade of Bucyrus, Ohio, desire propositions for an incandescent light franchise, and an election will soon be held in Columbus to settle the question of issuing $200,000 worth of bonds for a municipal electric lighting plant.

News has been received that the city of Starkville, Miss., will soon be in the market for a 150-horse-power boiler, a 90-kilowatt dynamo, a 125-horse-power engine, and other material. It is proposed to build an electric lighting plant to cost about $9,000. Professor E. C. Yard is the engineer.

Mr. Fred Macey, of Grand Rapids, Mich., is asking for bids at once on one 400-horse-power slow-speed Corliss engine, one 200-horse-power slow-speed Corliss engine, three 250-horse-power water-tube boilers, one 125-kilowatt 250-volt direct-current slow-speed belted generator, five shop motors, and other machinery. Messrs. Field and Hinchman, of the Majestic Building, Detroit, Mich., are the consulting engineers.

The secretary of the Riverside Power Company, of Riverside, Cal., J. H. Barber, states that bids will be received until August 15 for the construction of an electric power plant on the Santa Ana River to cost about $80,000. The water will be diverted by a canal six and one-half miles long and the fall at the power-house will be 86 feet. There will be two turbine water-wheels of 375 horse-power each, two 300-kilowatt three-phase alternating-current generators with an exciter to run a separate turbine-wheel and a 12½-mile transmission line. The voltage will be from 10,500 to 11,000. Samuel Storrow, 402 Douglass Building, Los Angeles, Cal., is the engineer.

INDUSTRIAL ITEMS

THE ELECTRIC APPLIANCE COMPANY, Chicago, advises customers to meet gas and gasoline competition by using the Adams-Bagnall three-and-one-half-ampere arc lamps. These lamps are made for all circuits.

THE WESTINGHOUSE COMPANIES have sent out a very attractive pamphlet describing their exhibits at the Pan-American Exposition and extending to every one a very cordial invitation to visit them.

McCARTHY BROTHERS & FORD, of Buffalo, N. Y., have received an order for marbleized switchboards which are to be sent to the Singapore branch of the American electrical engineering and contracting firm of Bagnall & Hilles.

THE HAZARD MANUFACTURING COMPANY, of Wilkesbarre, Pa., is distributing some very attractive booklets, describing its bare copper wire, insulated wires and cables, and another setting forth the merits of its wire rope of steel and iron.

THE WOODBINE HOTEL, of Buffalo, N. Y., has a beautiful location. All its rooms face Johnson Park, there being no court rooms. It is very cool because of the air space about it. All those contemplating a visit to the exposition will do well to send for illustrated booklet and maps.

WESTON ELECTRICAL INSTRUMENTS are interestingly described in a new pocket price list sent out by Mr. J. P. Brown, New York, selling agent of the Weston Electrical Instrument Company. The small volume embraces all the standard portable and switchboard instruments made by the Weston company, and is sent on application.

FIREWORKS of the most elaborate kind will be displayed at the Pan-American Exposition each Tuesday, Thursday, and Saturday evening during August, and possibly during September. These fireworks will be displayed by Pain, well known in connection with such exhibitions, and will take the form of a water carnival, including pantomimes, ballets, etc.

THE EUREKA ELECTRIC COMPANY, of Chicago, Ill., is sending out a very attractive catalogue of its telephone and line construction material. It manufactures express switchboards, flashlight switchboards, multiple switchboards, bridged telephones, series telephones, etc. Apparatus manufactured by this company is in use in over 1,200 exchanges in this country and abroad.

THE CONSOLIDATED CAR HEATING COMPANY, Albany, N. Y., has been awarded the contract to equip 1,200 cars with apparatus for electric heating by the Manhattan Elevated Railway Company, of New York. By the terms of the contract 300 cars must be ready by January 1, 1902. Eighteen months will be required to complete the work. Each car will contain eighteen heaters.

THE PERU ELECTRIC MANUFACTURING COMPANY, of Peru, Ind., is distributing an attractive pamphlet setting forth the merits of its fusible attachment plugs. It has designed to make a more practical plug than any on the market at present, to decrease the labor in using, and to increase the durability. The plug is dust-proof and moisture-proof. This pamphlet also contains the price list.

STROMBERG'S STEAM USERS' GUIDE is a working book giving complete information of the points necessary to be known by those having charge of steam apparatus, and especially for those liable to be questioned by examining boards for the grant of a license. Engineers, firemen, machinists and employers have found it of considerable value. It is published by George A. Zeller, of St. Louis, Mo.

THE LANE & BODLEY COMPANY, of Cincinnati, Ohio, is now distributing its Fiftieth Anniversary Catalogue. It contains details of its new twentieth century heavy-duty engine, the Columbian Corliss engine, four-cylinder triple expansion Corliss engine, and others. This catalogue should be of great assistance to those contemplating the purchase of engines for electrical as well as manufacturing purposes.

THE INTERNATIONAL SPECIALTY COMPANY, of Chicago, Ill., has issued a very neat circular describing its No. 1 telephone for office, house, or hotel. This telephone is guaranteed for five years. The maker has sought to build first the best working telephone upon the market, and second, to make it so cheap that it will be within the reach of all. Prices and further particulars will be furnished upon application.

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, has secured contracts from the Dublin corporation for furnishing the necessary transformers and meters to be installed in the principal generating station of the Irish capital's electric traction system. The combined contracts are upwards of $55,000. The transformers, etc., will be manufactured in the Pittsburgh factory of the American Westinghouse Company.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, has recently issued an electric fixture and supply catalogue, No. 28. It covers a very complete and up-to-date line of fixtures, illustrated with large half-tones and the catalogue is very handsomely gotten up. This company has recently enlarged its facilities for handling the electric fixture business and the factory is in position to make prompt shipments. This catalogue will be mailed, on application, to any one contemplating the purchase of fixtures.

CENTRAL ELECTRIC COMPANY—Any one desiring information on Manhattan arc lamps can procure it from the Central Electric Company, of Chicago, who, as agent for this lamp, will send descriptive bulletins and quote prices. The Manhattan is one of the oldest lamps on the market and long experience has brought many changes which have greatly improved it, although the main features of the old lamp have been maintained. The Central Electric Company will carry a stock of the various types in Chicago, in order to supply customers, who are in immediate need, without delay.

THE WISCONSIN TRACTION, LIGHT, HEAT AND POWER COMPANY, of Appleton, Wis., has recently placed an extensive order for turbine water-wheels with the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio. The plant consists of two units of wheels for driving the main plant, each unit containing three pairs of 42-inch Victor wheels mounted on horizontal shafts. The total horse-power to be developed by these wheels will be 3,200 horse-power, and the gate work will be its patented drawrod type. Two single 24-inch horizontal Victor turbines, developing 150-horse-power, will also be furnished for driving the exciters.

MR. GEORGE H. DANIELS, General Passenger Agent of the New York Central & Hudson River Railroad, has just issued vol. 1, No. 1, of the *Four-Track News*, a sequel to the very popular and widely known "Four-Track Series," formerly published by him. The *News* will be issued periodically, and will contain from month to month interesting news concerning the Central's lines and its entire system. It will be mailed regularly to over 5,000 correspondents in foreign countries, and a copy will be sent free to any address in the United States on receipt of a postage stamp by the General Passenger Agent, Grand Central Station, New York city. The *News* is attractively gotten up and presents matters of interest to every traveler.

NEW INCORPORATIONS

WENATCHEE, WASH.—The Wenatchee Electric Light and Power Company. $6,000.

CANONSBURG, PA.—The Canonsburg & Washington Street Railway Company. $48,000. To build a line eight miles long.

WASHINGTON, PA.—Washington & Oak Grove Street Railway Company. $18,000. To run through the streets of Washington.

PHOENIX, ARIZ.—The Brett Telephone and Telegraph Company. $100,000. Incorporators: Mrs. A. M. Brett and W. V. Smith.

MEADVILLE, PA.—Meadville & Interurban Street Railway Company. $96,000. To build 16 miles of road. President: F. R. Shryock.

FARMERSVILLE, TEX.—Farmersville Electric Light Company. $15,000. Incorporators: H. L. Carver, H. D. Honaker and L. E. Bumpass.

LITTLE ROCK, ARK.—Yellville Electric Light and Power Company. $50,000. Incorporators: W. F. Cleveland, J. E. Seaman, Alf Wingate and others.

NEW YORK, N. Y.—The Telephone Printing Company. $10,000. Directors: R. A. Salefield, E. H. Rosenblatt and F. A. Thompson, of New York city.

WILMINGTON, DEL.—Modern Street Railway Company, of New York. $100,000. To make and deal in articles for supplying light, heat and power.

JACKSON, MISS.—The Ackerman Compress Warehouse and Electric Light Company. $25,000. Incorporators: J. E. Cobb, A. C. Raymar and others.

WAVERLY, TENN.—The Waverly Electric Light Company, of Humphreys County. $5,000. Incorporators: Arthur E. Justice, B. R. Thomas and others.

McKEESPORT, PA.—McKeesport Suburban Street Railway Company. $12,000. To build a line two miles long. President: H. B. Rhine, of Bellevue, Pa.

BLOOMSBURG, PA.—Bloomsburg & Millsville Street Railway Company. $60,000. To run from Bloomsburg to Millsville. C. W. Miller, of Bloomsburg, president.

ALTOONA, PA.—The Belt Line Extension Street Railway Company. $3,000. To build one-half mile of railway. President: Charles P. Baltzell, of Altoona, Pa.

CHICAGO, ILL.—The Valparaiso, Michigan City & Chicago Electric Railroad Company. $25,000. Incorporators: William Freeman, C. W. Bartholomew and others.

CONNEAUT, PA.—The Conneaut & Erie Traction Company. $150,000. To build 25 miles of railroad from the city limits of Erie to the Ohio state line. J. S. Cleve, of Erie, president.

TEXARKANA, ARK.—Texarkana Brick Company. $25,000. Incorporators: George W. Fouke, president; Clyde W. Fouke, vice-president; E. N. Maxwell, secretary, and William L. Haydon, treasurer.

COLUMBUS, OHIO—The Benbow Company. $5,000. To manufacture electric machines and supplies and to deal in second-hand electrical machinery and supplies. Incorporators: Albert F. Beck, Robert S. Bruce, J. Lahey, M. B. Benbow and W. C. Benbow.

HARRISBURG, PA.—The Beaver & New Brighton Electric Street Railway Company; $30,000; to build a line five miles in length. The Freedom & North Rochester Electric Street Railway Company; $18,000; to run through Freedom and Rochester and return, a distance of three miles. The Union Electric Street Railway Company; $6,000; to build a line one mile long.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED AUGUST 6, 1901.

679,731 Telephone exchange system; W. M. Davis, Chicago, Ill.

679,760 Electric elevator controller; N. O. Lindstrom, New York, N. Y.—An electrically-actuated elevator, comprising the car, the actuating machine and its main circuit, a circuit across the brushes of the machine, and means for closing the latter circuit each time the main circuit is opened.

679,769 Electrical hot wire measuring instrument; P. Meyer, Berlin, Germany.

679,788 Telephone exchange system; D. Sinclair, London, England.

679,803 Manufacture of filaments for incandescent electric lamps; W. L. Voelker, London, England.

679,805 Test system for multiple switchboards; H. G. Webster, Chicago, Ill.

679,812 Method of regulating double-current dynamo-electric machines; J. L. Woodbridge, Cambridge, Mass.—In the operation of a double-current, dynamo-electric machine, adapted to develop or utilize both alternating and direct currents in the same armature winding, the method of varying and controlling the relation between the alternating and direct-current electro-motive force developed in the armature, which consists in varying the distribution of the lines of magnetic force over the pole-face, in a general direction parallel to the adjacent direction of armature motion.

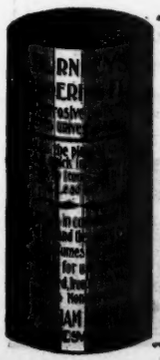
679,813 Means for regulating double-current dynamo-electric machines; J. L. Woodbridge, Philadelphia, Pa.

679,824 Art or process of refining lead by electrolysis; A. G. Betts, Lansingburg, N. Y.

679,877 Electrode for arc lamps; H. Bremer, Neheim, Germany—An electrode for arc lamps, composed of pure coal and of 10 to 70 per cent of metallic salts or metalloids, as calcium, magnesium, glass, fluor-spar, or the like, in combination with an addition of a high quantity of boron and fluorin.

679,878 Electric arc lamp; H. Bremer, Neheim, Germany—Consists of two pairs of downwardly pointed parallel or converging carbon pencils, arcs between them, a metal chamber surrounding the carbon points, said carbons containing an addition of metallic salts.

(Continued on page 32.)



PATENTED
BURNLEY SOLDERING PASTE.
Universally acknowledged the best. All others imitations.
250,000 ½lb. boxes
sold in 1900. Put up in 1-4, 1-2, 1, 5 and 10 lb. packages.
BURNLEY BATTERY MAN'F'G CO.
PAINESVILLE, OHIO.
Burnley Dry Batteries are superior.

PATENTS.
Twenty years' continuous practice with the Western Union Telegraph Company, American Bell Telephone Company, General Electric Company, Electrical Accumulator Company, Postal Telegraph-Cable Company, and other electrical companies.
Correspondence and interviews solicited.
W. B. VANSIZE, 253 Broadway, N. Y.
Solicitor and Expert.

PATENTS.
Caveats, Trade-Marks, Copyrights and Designs.
Send Your Business Direct to Washington. Saves Time, Costs Less, Better Service.
My office close to U. S. Patent Office.
PERSONAL ATTENTION GIVEN— 20 YEARS' EXPERIENCE.
Book "How to Obtain Patents," etc., sent free.
E. G. SIGGERS,
948 F St., N. W., WASHINGTON, D. C.

PATENTS Trade-Marks Copyrights
EDWARD S. DUVALL
(Formerly with Benj. Butterworth, late Commissioner of Patents).
Patent Lawyer,
American and Foreign Patents Secured Promptly. Moderate Fees.
Infringement Suits. Interference Cases.
Opinions on Scope or Validity of Patents.
Expert Examinations of Patent Office Records.
Abstracts of File Wrappers of Applications before Patent.
OFFICES:
LOAN & TRUST BUILDING,
OPP. PATENT OFFICE,
WASHINGTON, D. C.

"Why and How"
Do you wish to understand the principles, methods and history of the every-day industrial, technical and scientific processes and operations that you have seen and wondered at? How done, and Why done, in certain ways?
SCIENCE AND INDUSTRY
We explain the things everyone wants to know. Our articles are both interesting and accurate—a combination not found in any other popular-science publication in print. Send 25 Cents in Stamps for a Three-Months' Trial Subscription. You will like us.
SCIENCE AND INDUSTRY,
$1.00 PER YEAR.
An Illustrated Monthly Magazine. SCRANTON, PA.

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER

U. S. 2½ VOLTS.
STORAGE BATTERY
NOW READY.
The only Storage Battery shipped Fully Charged and Dry with liquid in separate vessel. Further details by mail.
U. S. BATTERY COMPANY,
552-558 State St., Brooklyn, N. Y.
BRANCHES:
Chicago: 34 W. Monroe St. Boston: 141 Franklin St.
Factory and Laboratory, 552 State St., Brooklyn.

Woodbine Hotel
FACING JOHNSON PARK, BUFFALO
Is the best located of any of Buffalo's permanent hotels. All rooms face the park; no court rooms. Cool because of air space about it and covered with woodbine. Send for illustrated booklet and maps.

Purdue University
LA FAYETTE, IND.
Courses in
ELECTRICAL ENGINEERING,
CIVIL ENGINEERING
MECHANICAL ENGINEERING,
Extensive Laboratories. Fine Equipment.
Catalogue Sent on Application.

THE BRADY MAST ARMS
T. H. BRADY, New Britain, Conn., U. S. A.
MANUFACTURER OF
Mast Arms, Pole and Swinging Hoods, House Brackets and other specialties for construction work
Catalogue and Prices Furnished on Application

$5 VOLT AMMETER FOR STUDENTS' USE.
(Jewell Bearing and Aluminum Case.) Adapted to primary and storage battery work. List of schools using it mailed on application. The method of its use described in a circular just issued.
L. E. KNOTT APPARATUS CO.,
16 Ashburton Place, - - BOSTON, MASS.

ELECTRICAL ENGINEERING TAUGHT BY MAIL
Write for our free illustrated book "CAN I BECOME AN ELECTRICAL ENGINEER?"
We teach Electrical Engineering, Electric Lighting, Electric Railways, etc., at your home by mail. Institute indorsed by Thos. A. Edison.
ELECTRICAL ENGINEER INSTITUTE
Dept. M, 240-242 West 23d St., New York

W. R. OSTRANDER & CO.
22 DEY STREET, NEW YORK.
MANUFACTURERS OF
Speaking Tubes, Whistles, Annunciators.
Electric and Mechanical Bells.
FACTORY: DEKALB AVE. BROOKLYN.
Send for Illustrated Catalogue.

ELECTRIC HEATING APPARATUS
OF EVERY DESCRIPTION.
The Simplex Electrical Co.
CAMBRIDGEPORT, MASS.

ELECTRIC HEATING APPARATUS
All Kinds for All Purposes
Hadaway Electric Heating and Engineering Co.
107 Liberty Street, NEW YORK

PARSELL & WEED,
MODEL MAKERS.
Electrical, Experimental and Fine Tool Work
Write for Booklet.
The Franklin Gas Engine Sets of Castings and Material; Finished Parts and Complete Engines. Write for Gas Engine Circular No. 2. Telephone, 156 Madison Square.
THE FRANKLIN MODEL SHOP,
129-131 West 31st Street, New York City.

CASE BROTHERS
MANUFACTURERS OF
INSULATING AND FULLER BOARDS
All Grades and Thicknesses
Heavy Special Boards to Order
Orders promptly filled from large stock on hand
Correspondence solicited
Highland Park, Conn.

Money and time saved by our Ground Locators by Telephone, Telegraph and Lighting Companies. Bona fide orders filled on trial.
THE MYERS BREAK FINDER CO.,
SYRACUSE, N. Y.

PATENTS.

(Continued from page 31.)

677,897 Self-restoring fuse-block; M. L. Jones, Montgomery, Ala.

679,924 Electrical controlling means for winding machines; R. Varley, Jr., Jersey City, N. J.

679,926 Manufacture of filaments for incandescent lamps; W. L. Voelker, London, England.

679,930 Cord-adjuster for electric lamps; Geo. Webster, Christiania, Pa.

679,953 Trolley wire-hanger; A. D. Crossley, South Norwalk, Ct.

679,973 Electric furnace; D. Lanck, Paris, France—A reaction chamber, having a gas-inlet in its upper part and a gas-outlet in its lower part, means in the upper part of said chamber for subdividing the gases therein, resistance wires adjacent to the walls of said chamber, and electrical connections with the said wires.

679,985 Process of manufacturing sulphates of copper; H. Palas, Marseilles, France.

679,997 Electrolytic process of obtaining metals from their fused compounds; G. P. Scholl, Philadelphia, Pa.

679,998 Counting telephonic messages; G. Seligmann-Lui, Paris, France.

680,001-002 Wireless telegraphy; H. Shoemaker, Philadelphia, Pa.—In a system of wireless telegraphy, a transmitting and a receiving station, said receiving station having therein a relay, a recorder-magnet, means for producing three magnetic impulses in the recorder-magnet to every one received in the relay.

680,024 Telegraph-relay; J. E. Cordovez, Panama, U. S. Columbia.

680,036 Electrical signaling system; J. A. Gehrung, St. Louis, Mo.

680,059 Electrical call or alarm device; A. B. Miller, Newark, N. J.

680,077 Telephone transmitter arm-joint; H. B. Sabin, Cleveland, Ohio.

680,082 Electric arc lamp; H. Stenz, Chicago, Ill.

680,120 Electric fan; E. W. Brown, Dayton, Ohio.

680,134 Electrical contact apparatus; K. De Kando, Budapest, Austria-Hungary—The roller contact part, an insulating-rod within the said roller contact part, the ball bearings between the roller contact part and the insulating-rod, and the sliding contact part bearing against the rolling contact part.

680,150 Electric cable; C. A. W. Hultman, Stockholm, Sweden—An electric cable, comprising a plurality of wires, air insulated from one another and helically twisted.

680,151 Underground conduit for electric conductors; C. A. W. Hultman, Stockholm, Sweden—A conduit for electric conductors, comprising sections arranged end to end and having one or more passages for a conductor or conductors and a water-proof sheathing for each of said sections, constructed to telescope on to the sheathing of an adjacent section.

ELECTRICAL DEVICES

of all kinds are our specialty.

We do anything that can be done with a clock.

We also make Time Switches, Frying-pan, Program, Sixty-day, Calendar and Synchronized Clocks.

Send for Catalogue No 701.

The Prentiss Clock Improvement Co.,
Dept. 70, 49 Dey St., N. Y. City.

U. S. ENGINEER OFFICE,
735 N. Capitol St.,
WASHINGTON, D. C., Aug. 9, 1901.

Sealed proposals will be received here until noon, September 9, 1901, and then publicly opened, for furnishing Distributing Centers for electric lighting and power circuits for New Building for Government Printing Office. Information furnished on application.

JOHN STEPHEN SEWELL,
Capt. Engrs.

WANTED—

Experienced Salesman for Electric Lighting and Railway Supplies to travel in New York and Northern Pennsylvania, giving age, references, experience and salary expected.

A. B. C.,
Care of ELECTRICAL REVIEW,
13 Park Row, New York.

MECHANICAL ENGINEER, now employed as Chief Engineer, desires position with some large Electrical or Construction Company. Has designed, built and operated several Electrical Plants both water and steam power. Good executive and business ability. Familiar with general construction work. Will go anywhere Address ENGINEER,
Care ELECTRICAL REVIEW.

WANTED—

An Electrical Engineer of experience by a large manufacturing company. Must be active, systematic, and thoroughly posted on calculation and testing of modern direct-current apparatus from the smallest size to 100 K. W. capacity. Permanent position to the right man.
Address, DIRECT,
Care of ELECTRICAL REVIEW.

WANTED

Practical Electrician with business experience to take interest and to have full charge and management of works This company is an old established firm and is doing a large business. It has one of the most modern and up-to-date shops which is equipped with electrical machinery throughout. It has a complete line of direct-current apparatus, ranging in size from 1 h.-p. to 260 h.-p. It has been doing business in this line for eleven years. Trade is thoroughly established throughout the United States. This is an exceptional opportunity for the right man. Investigation is solicited and will be desired in return by the company.
Address A. E. M.
Care ELECTRICAL REVIEW, New York.

New Wabash Equipment.

The Wabash Railroad has just received and placed in service on its lines running out of Chicago the following new equipment: Eight Combination Baggage and Passenger Coaches, thirty Palace Day Coaches, ten Reclining Chair Cars, three Café Cars and two Dining Cars. The majority of these new cars are seventy feet in length, and fitted with the latest style wide vestibules. They have six-wheel trucks with steel wheels. The cars are finished in the finest selected St. Jago mahogany. The lighting is by Pintsch gas with the exception of the café, dining and some of the chair cars, which are unusually well lighted by electricity, the fixtures being especially designed for these cars. The dining cars will seat twenty-nine persons and have ample kitchen space. The café cars will seat eighteen persons, and have a library and smoking room in the observation end of the car which will seat fourteen persons. These cars also contain a private café with seating capacity for eight persons. These new cars represent the highest stage of development of modern car building. Nothing has been omitted and no expense spared that would add to their luxurious elegance, or to the comfort and convenience of the patrons of the Wabash road.

No line is now better equipped than the Wabash for handling business to the Pan-American Exposition. Write for a copy of Pan-American folder, containing a large colored map of the Exposition grounds and zinc etchings of the principal buildings.

F. A. PALMER, Asst. Gen. Pass. Agt.,
Chicago, Ill.

ENGINEERING CARDS.

THOS. J. McTIGHE, CONSULTING ENGINEER.
Mechanical, Reports,
Electrical, Estimates,
Mining, Supervision,
Inventions.
1138 Park Row Building,
13-21 PARK ROW, NEW YORK.

JOSEPH B. BAKER
Consulting Electrical Engineer
TELEPHONY INVENTIONS REPORTS
Office and Laboratory
40 Lincoln Street, BOSTON, MASS.

J. G. White & Company,
INCORPORATED,
ENGINEERS, CONTRACTORS,
29 Broadway, New York, N. Y.
LONDON:
J. G. White & Co., Ltd., 22A College Hill, Cannon Street.

SHEAFF & JAASTAD,
MECHANICAL and ELECTRICAL ENGINEERS.
Plans and specifications for and superintendence of Electric Power and Lighting Plants a specialty.
85 WATER STREET, BOSTON, MASS.

New England Engineering Co.
100 BROADWAY, NEW YORK. WATERBURY, CONN.
Electric Railways, Electric Light and Power Plants, Gas and Waterworks, or any other engineering installations built or remodeled.

CONTRACTING AND CONSULTING ENGINEERS

should be represented in this column

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.

Thorough Inspections
AND
Insurance against Loss or Damage to Property and Loss of Life and Injury to Persons caused by
Steam Boiler Explosions

J. M. ALLEN, President.
WM. B. FRANKLIN, Vice-President.
F. B. ALLEN, Second Vice-President.
J. B. PIERCE, Secretary.
L. B. BRAINERD, Treasurer.
L. F. MIDDLEBROOK, Asst Sec.

Our Students Succeed

Our instruction helps students to better positions and higher salaries. This is what a student says:

A Lineman Benefited.

My course has been a benefit to me in many ways. When I enrolled, I was working as a lineman. Owing to the excellence of your instruction, I was advanced to the position of dynamo tender, and then to trimmer, with an increase in wages. I am now getting practical experience in handling machinery and winding armatures. I shall always be a good friend of the schools.

FRED W. HOUGHTALING,
Three Rivers, Mich.

Instruction by Mail

for Electrical Workers in Electrical Engineering, Power and Lighting, Railways, Lighting, Car Running. Monthly payments.
When writing, state subject in which interested.
INTERNATIONAL CORRESPONDENCE SCHOOLS
Established 1891. Capital $1,500,000.
Box 1003, Scranton, Pa.

NOVELTIES IN
Reflector Shades
FOR INCANDESCENT ELECTRIC LAMPS

F. EULER
MANUFACTURERS' AGENT
35 Broadway New York

"STELLARC" The Best Arc Lamp Made
JOHN A. HAMBLIN
12 Beverly St., Providence, R. I.